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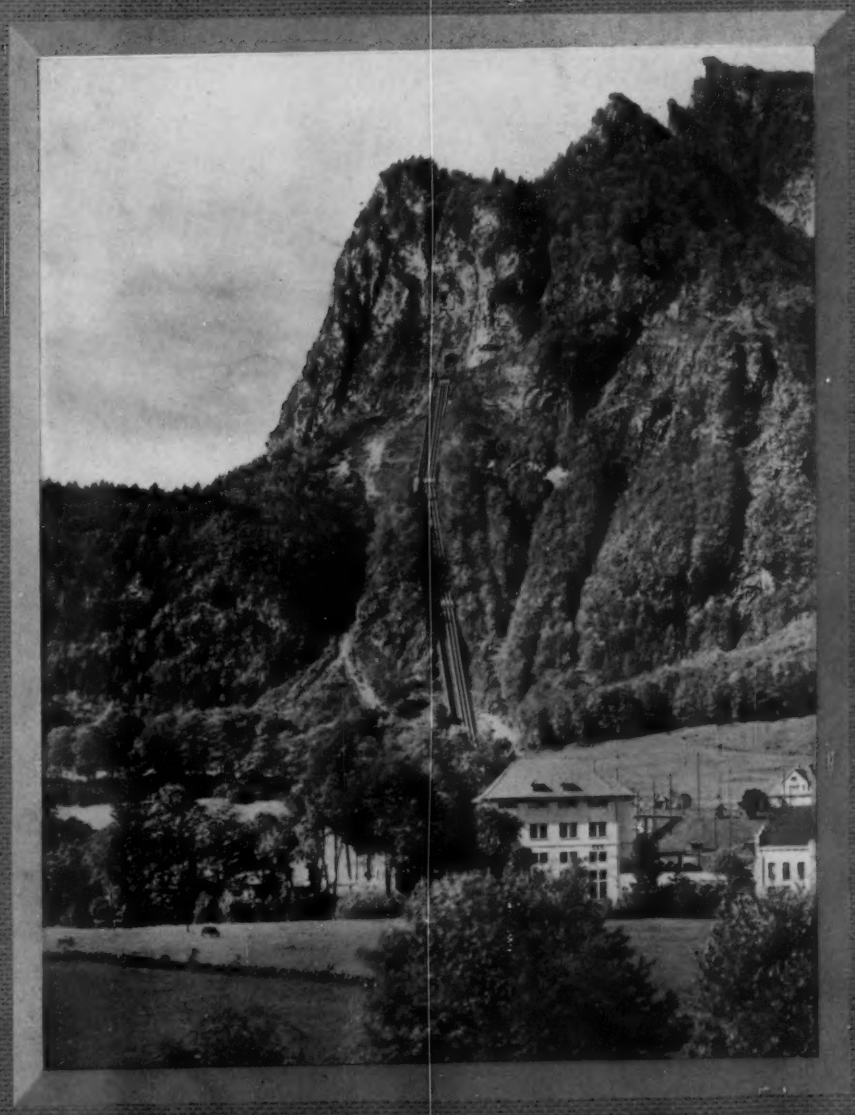

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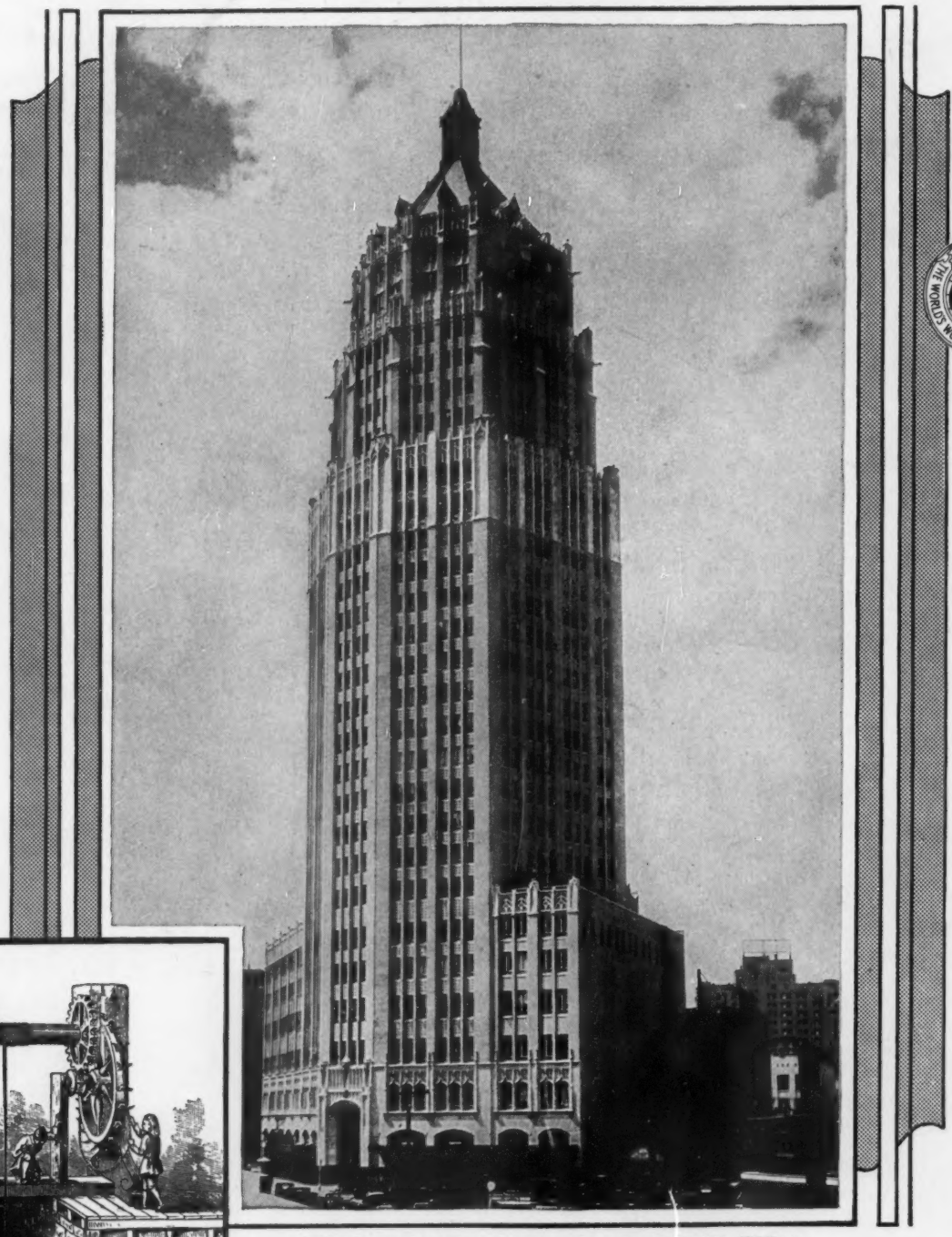
VOLUME X, NO. 8
JANUARY, 1930



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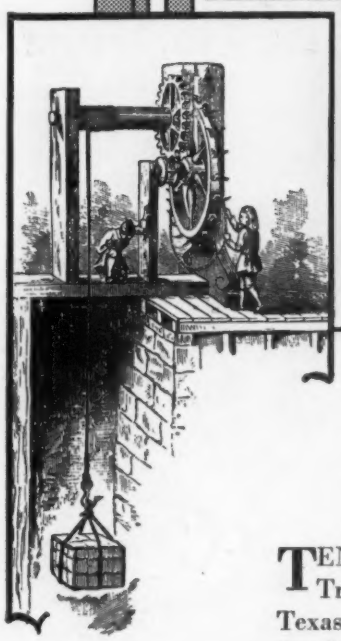

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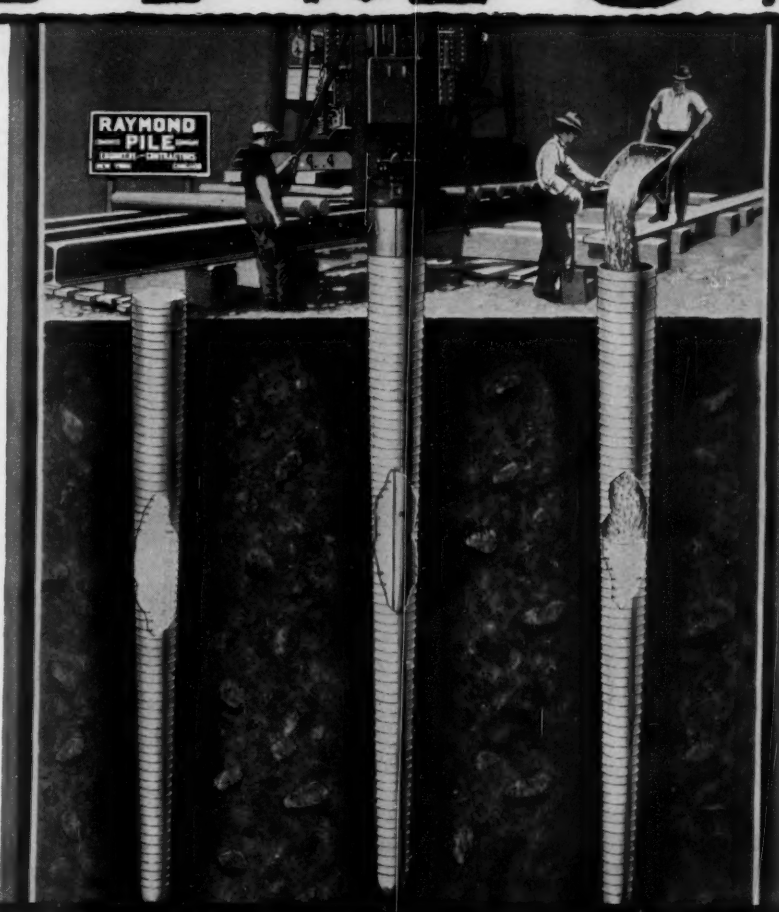

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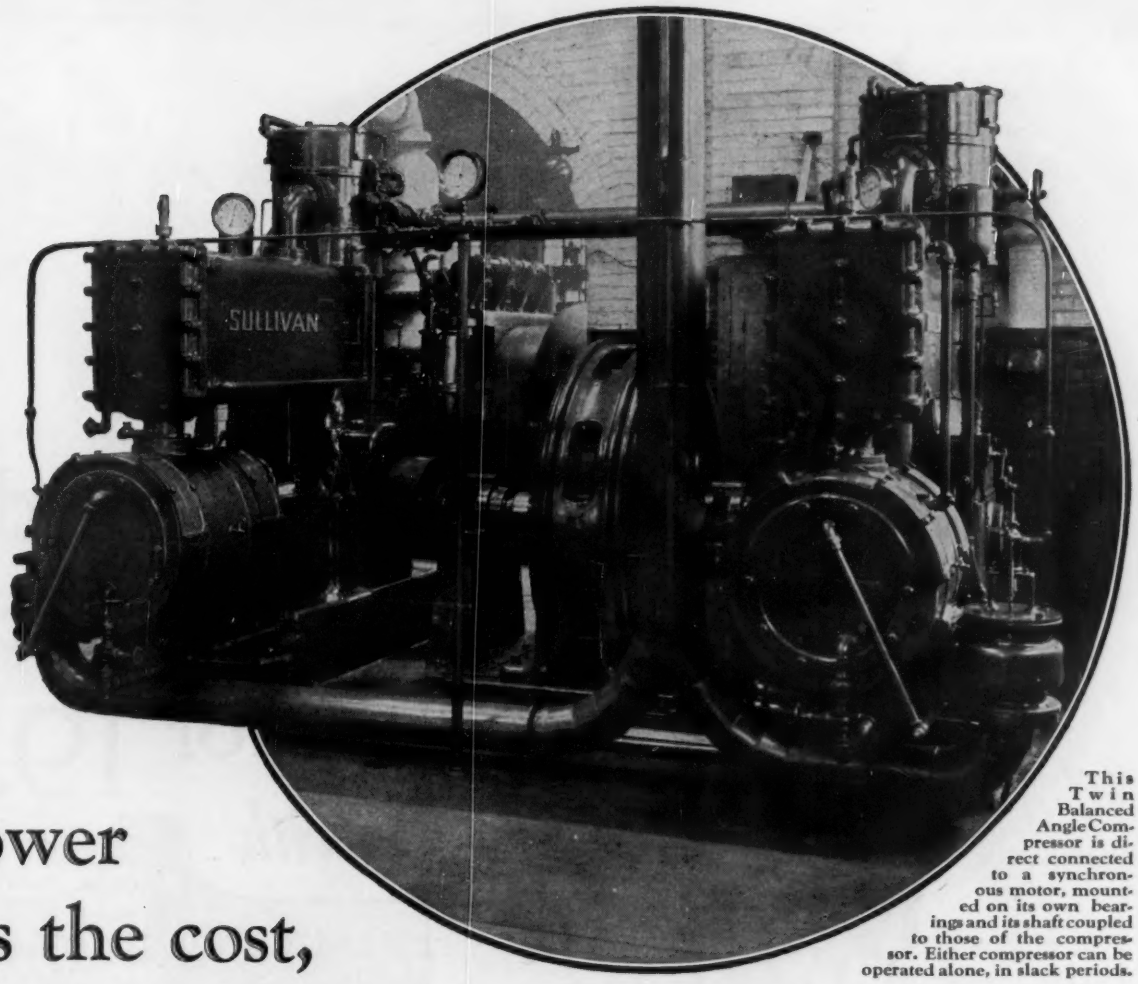

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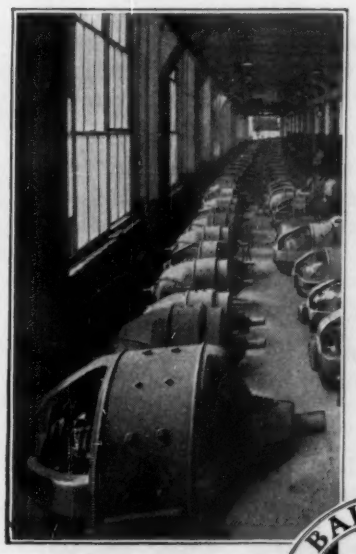

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THE TECH ENGINEERING NEWS

Volume X CAMBRIDGE, MASS., JANUARY, 1930 Number 8

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Among Our Authors

TECHNOLOGY men may take pride in the story of "The Akron Zeppelin Hangar," for Paul W. Litchfield '96 is at the head of the Goodyear Zeppelin Corporation, as well as its parent organization, the Goodyear Tire and Rubber Company. Today he is recognized as one of the pioneers of lighter-than-air activities in the realm of aviation. It has been said of him, "A keen mind, a flawless logic, extraordinary common sense, an impatience of what is irrelevant, and the penetrating power of going swiftly to the very heart of every subject that he touches — all these attributes are mellowed and made trebly valuable by a sense of humor which sets things in their proper light and views them in a true perspective."

MEMBERS of the three upper classes of M. I. T. will have a personal interest in the article on "Design Problems of a New Car," as Adam K. Stricker, Jr. was a well-known member of the Class of 1929, graduated last June. While here at the Institute he took a great interest in the field of automotive engineering and, in summer work, established connections with the Cadillac Motor Car Company, by which he is now employed. Theirs is the first sixteen-cylinder car to be placed in production, and it is being exhibited for the first time at the New York Auto Show this month. Very little information has been available concerning the new engine, and much of the material of the article which we are publishing is making its appearance in the technical press for the first time.

MR. ZOGBAUM, author of the article dealing with the remotely controlled power distributing station of the New York Edison Company, is a graduate of the course in Electrical Engineering at Columbia University. Prior to the outbreak of the World War he was connected with the electrification of the New York, New Haven and Hartford Railroad. He was overseas as a member of A. E. F. for two years, with the rank of Lieutenant in the Engineers. Before going with his present employers he was for seven years with the Western Electric Company and the Bell Telephone Laboratories, Inc. His past experience and his intimate connection with the installation of the remote control system eminently qualify him to describe it to our readers.

H. P. HOLMAN has had long experience of various lines of applied chemistry. His education was received at the Universities of Indiana and Wisconsin, and he is now a Senior Chemist in the Industrial-Farm Products Division of the Bureau of Chemistry and Soils of the United States Department of Agriculture. The subject of the chemical disposal of farm wastes of which he writes is but one of the phases of the work of the Bureau which carries on chemical and technological research on problems relating to leather, paper, turpentine and rosin, waterproofing and preservative treatments for fabrics, as well as the utilization of cornstalks.

"Listen to this"----

"LISTEN TO THIS," said Dan over the lunch box. "When my street car got close to the tunnel, I spotted two kids on the trestle of the steam railroad watching the traffic below. All of a sudden along comes the steam train swingin' around the curve at a fast clip, and the young 'uns couldn't see it. Yell! yes, plenty and ringin' the gong like the devil, but nary a bit of good did it do until—well they started to run. One got clear, but Guy tripped on somethin' ....fell....*sprawled on the tracks*. The locomotive hit him....knocked him between the rails. The whole Works rolls over him. Just as the third coach was going over, Guy sort of raised up and whack! something hit his head. We all thinks it's the end. I runs over and grabs him. Took his sweater off and puts it under his head. His hip was dislocated so I sets it again. The kid wasn't breathing. I rolled him over on his face and gave him prone-pressure treatment. Didn't have much luck at first but finally he opened his eyes. As soon as I stopped he went cold, so I began again as if he was my own kid. Pretty soon he came to—this time to stay."

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THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME X JANUARY, 1930 NUMBER 8

THE AKRON ZEPPELIN HANGAR

Built for the manufacture and housing of the Navy's new 6,500,000 cubic feet airships, it is the largest structure in the world without interior supports

By MARK L. FELBER
Goodyear-Zeppelin Corporation

A MARVEL of twentieth century engineering is the gigantic airship dock at Akron, Ohio, just completed in record time. When the Goodyear-Zeppelin Corporation was awarded a contract in October, 1928, to build two super-Zeppelins for the United States Navy, the first problem confronting the company was the planning and erection of a structure in which to construct them. The first of these ships, the ZRS4, the agreement stipulated, must be completed by May 1, 1931, thirty months following the date of the signing of the contract.

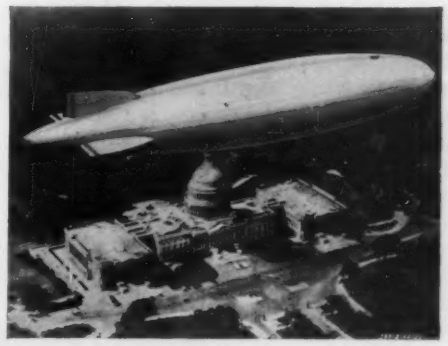
Careful planning and designing of a mammoth airship factory and dock at once occupied engineers and aeronautic experts, as many intricate phases of the subject had to be considered. One million cubic yards of earth and tons upon tons of muck had to be removed. Layers of selected gravel and clay, to a depth of six feet, had to be laid, and thirteen hundred concrete piles set. Large tasks faced the company in the handling of the seven thousand tons of steel that would go into the structure.

Working on schedule, however, all plans were approved and, to meet the demands in connection with the delivery of the first ship to the Navy at the time agreed upon, it was decided that the airship factory and dock must be completed by January 1, 1930. And it was finished just a few days before that date.

The erection of this, the largest building in the world without interior supports, was a herculean task, but, realizing the magnitude of the project and the importance of having the structure completed on schedule the work was entered upon with a full understanding of the various phases of the undertaking. It was imperative that men of genuine earnestness and real ability be employed. Rigid regulations were laid down, with the result that the status of operations on the building each month showed progress according to schedule. There were times, of course, that complications arose. This was to be expected on a project of such magnitude, but despite various obstacles everything moved quite in harmony with the well-laid plans.

The large force of men at work fully appreciated the many aspects in connection with the task and labored patiently, earnestly and persistently —"hammering away," as it were — on a huge structure big enough to cover the National Capitol or house the Woolworth building and the Washington Monument placed lengthwise. The building is 1175 feet long, 325 feet wide and 210 feet high. It is the product of the engineering of W. C. State, consulting engineer, and Dr. Karl Arnstein, director of engineering for the company.

In the beginning, after the contract was awarded for construction of the



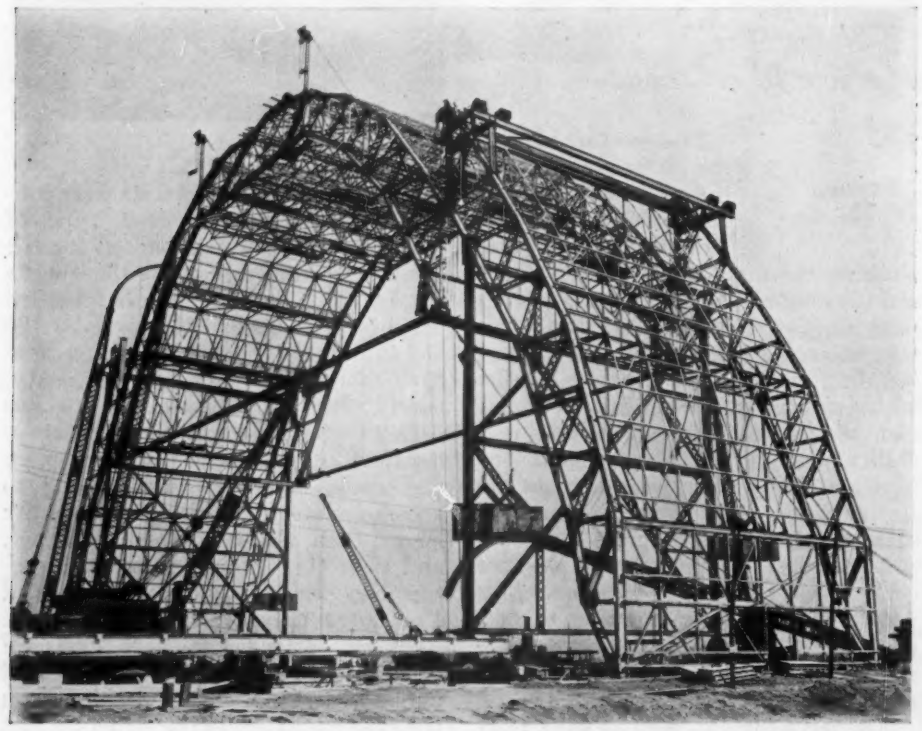
two ships for the Navy, tests were conducted to determine what type of building would best be suited for the construction and housing of the world's largest dirigibles. It will be recalled that the ZRS4 and ZRS5 will be 785 feet long, 135 feet in diameter and 6,500,000 cubic feet gas capacity, nearly three times the size of the Los Angeles and about twice the size of the Graf Zeppelin. The airship factory and dock, however, was planned to accommodate an airship considerably larger than the two under contract, and with that end in view the structure can conveniently house a ship of 10,000,000 cubic feet capacity. Dr. Arnstein, after exhaustive tests of building types in wind tunnels and under stress calculations, decided upon the type embodied in the structure just completed.

The raising of the first of the huge steel arches was an engineering spectacle that challenged imagination. The center portion of the immense steel bay, weighing 360 tons, rose slowly from the ground to the top of the two side legs, which had previously been erected and bolted into place. When this was completed, the spectators saw an intricate mass of steel, resembling an arch of a great bridge, weighing in total 620 tons and forming the center bay. Eleven more arches of approximately the same size as the first were erected, making

twelve bays in the great building. Months of preparation had preceded the erection of the first arch.

The stream-lining principle, familiar on boats, planes and automobiles, was carried into this structure in the effort to make it contribute again to the safety of airship operation. This stream-lining effect was carried out even to the doors, which resemble orange-peel sections. The method of lifting the great central portion of an arch into place was never before used in the construction of a building, according to W. C. State, consulting engineer, who explains just how the weight was lifted and other details of the operation.

"Four powerful steam cranes, one at each corner of the section, and operating in unison with each other, performed the major part of the lifting task, taking care of 80 per cent of the weight, while eight counter weights, composed of metal boxes filled with scrap iron and weighing 300 tons, lifted the remaining 20 per cent. The counter



RAISING THE GREAT CENTRAL ARCH

The span was raised into place by railroad derricks and counter-weights placed at the corners

weights, operated on a pulley, drew up the ends of the center portion as they slowly descended. The great central piece was lifted about six feet from the ground and allowed to remain at that height overnight to take up the tension in the lifting cables. Working slowly and deliberately, four to five hours were spent the next day in lifting it into position.

"Another engineering feat of great interest was witnessed when the ends of the center span neared the tops of the end girders. These end legs were being supported by steel false work, at the base of which were hydraulic jacks, and this hydraulic pressure was used to force the ends outward and allow the central portion to pass them. The operation of each of the four jacks in unison was quite an accomplishment in itself. Automatic measuring equipment gave the exact level of each end of the false work, and workmen kept in touch with one another, constantly checking, by telephone."

Because of the hugeness of the building, special attention had to be given to the design of the structure itself and especially the doors, to insure the building being such as to reduce the likelihood of wind gusts forming about the entrance. If the design of the building were such as not to disturb the natural wind conditions, half the hazard of handling the giant dirigibles in the vicinity of the dock would be eliminated.

In Dr. Arnstein's tests it was found that sliding doors for this mammoth building would, with some wind conditions, increase the wind velocity to double the normal speed around the entrance to the dock. This brought about the decision to building the doors in the shape of a quarter of an orange, fastened by a pin at the tip and rolling alongside the building when opened — operated on trucks on standard gauge railroad track. Not considering the snow that may accumulate on the doors, or the wind pressure against them, each door alone weighs 600 tons. Obviously, the simplest way to mount this heavy leaf so that it could be moved back and forth was on wheels. These wheels are spaced almost uniformly in pairs under the long curved structural steel sill which constitutes the base of the door.

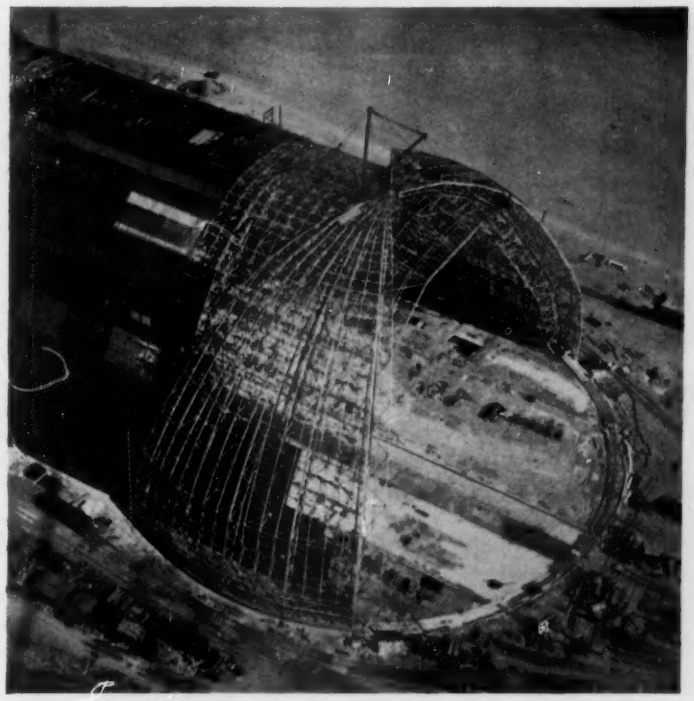
The radius of the curved standard gauge track is 188 feet to the center between the rails from a point projected down from the huge pin above. To carry this heavy weight on the ground a curved runway, built of reinforced concrete, ten feet wide and deep enough to go below the frost line, is provided, and under this runway is a series of concrete piles driven to solid rock. The hinge pin is 17 inches in diameter and six feet long. The bearing ball is 30 inches in diameter. The pin can not be regarded as being always fixed in the same spot, although tons of metal are used to make it fast. In a building the size of the Zeppelin dock the sun's heat will cause expansion and contraction that will move the entire roof, and wobble the pin several inches.

The doors move at the rate of about 20 feet per minute, so it will be seen that about five minutes' time is required to open or close a door. The opening or closing is an operation handled by an electrical contrivance. Electric cutout switches are mounted on the runway adjacent to the driving units, so that as projections from the door operate them the door comes to a slow-down and creeping speed automatically as the two leaves come together at the center, or as the doors come to the extreme open position. This makes it only necessary for the operator to push a button to start the door, after which it opens and stops or closes and stops, as the case may be, automatically.

The driving units are set under separate roofs outside the dock for the reason that the pressure against the rack resists the outward pressure against the wheels, due to the door weight, and, further, there must be no objectionable sparks from the control switches in the event hydrogen gas is ever used in the bags of the dirigibles. It is estimated that it may require at times of heavy snow and wind as much as 50 tons pressure to start the doors in motion, but ordinarily much less. The question might possibly be raised as to why roller bearings were not used to materially reduce the effort. While the roller bearing would without doubt reduce the starting effort to a fraction of the amount required for the plain bearings, they would, on the other hand, similarly increase the more serious problem of control in slowing and stopping.

The operation of the doors is inter-

esting. Pressing the button to open or close the doors starts the equipment on the high-speed motor winding, and accelerates the same to full speed. Travel continues at full speed until the first slow-down limit switch is encountered in that direction. This inserts secondary resistance in the high-speed winding, causing the motor to show a lagging tendency. When the second slow-down switch is encountered the motor is disconnected from the high-speed winding and thrown into slow-speed connections with secondary resistance. This causes the motor to decelerate to half speed and below, depending upon the amount of secondary resistance left in the circuit on the low-speed winding. The door then moves at slow speed until the final stop, at which time power is entirely disconnected from the equipment, including the hydraulic operated brake. The hydraulic brake is so arranged that after cutting off the power there is an inherent time lag of 1½ to 2½ seconds before the brake is finally set. It should be noted that the setting of the brake is a gradual application.



VIEW OF ORANGE-PEEL DOORS BEFORE COVERING

Doors are constructed to slide back along the sides to prevent formation of wind gusts and eddies

One of the unique features of the structure is the absence of all expansion joints. The center arches are fixed in position, while all others are carried on rollers, allowing the building to expand or contract freely from the center to either end. This permits the end arches, supporting the upper door pintles or hinges, to move laterally about four inches under the maximum range of temperature, a motion which is taken up partly on the pins themselves and partly transmitted to the doors and absorbed by the deformation of the door frames.

The building, being primarily a factory for the construction of airships, is equipped with many mechanical handling devices. At the center of the building, overhead, there is a single crane runway consisting of a 12-inch I-beam supported on the trusses. This runway carries a six-ton electric hoist for handling material. At each side of the center are two 12-inch I-beams, designed to carry working platforms which can be lowered or raised to any desired height, and on which the workmen engaged in assembling the ship's structure are employed. Further down the curved sides of the building are more I-beams for carrying additional working platforms. Other platforms also have been provided. At the center of the huge dock is a fixed working platform, the full length of the building, and at various levels, six on each side, are catwalks two feet wide. These likewise run the full length of the building.

Access to the upper platform is provided by two stairways, one on each side of the building, near the center, and by a specially designed inclined railway, to transport men and materials to the upper levels. This inclined railway consists of two counter-balanced cars running on a curved track but so built that the cars themselves remain horizontal at all times.

At the center of the building, just under the floor, is a service tunnel extending the full length of the dock. This tunnel contains electric outlets for both power and lights, water lines, compressed air lines and the gas lines for inflating the gas cells.

The main floor of the great building is used for assembling the duralumin rings of the airships, and it is essential that it should be level and provide ample support for holding down clamps. The floor is of concrete, six inches thick on a six-inch rolled slag base. It has specially designed inserts for holding down the clamps as well as holding down rings, also specially designed for securing the ship itself.

As to heating the structure, the engineers considered it useless to attempt to plan a heating plant. The offices and shops are heated by independent gas-steam radiator units, and electric heaters will be used on the floor and on the platforms in cold weather. Only a very small amount of natural light is provided, and all operations, to a great extent, require artificial light. Three reasons were assigned for doing this. First, the fact that assembly would call for continuous work, day and night. Second, the difficulty of making skylights water-tight. Third, the fact that even with ample windows much of the work would be done by artificial light, owing to the interference of the assembled ship with the light from the outside.

Electric current is brought to the site at 22,000 volts to a transformer building just outside the main structure, near the center, on the east side. This current, as well as all other utilities, is carried underground, as no

(*Continued on page 420*)

FULL-LENGTH VIEW OF HANGAR

The semi-elliptical shape of the building and the doors are well shown in this aerial view

Design Problems of a New Car

The first sixteen-cylinder car to be placed in production contains many unusual features

By Adam K. Stricker, Jr. '29
Cadillac Motor Car Company

THE new Cadillac V-16 is of exceptional interest from the standpoint of the engineer as an illustration of how factors of design may be made to yield certain prescribed results from a performance standpoint. This article will discuss the V-16, the first sixteen-cylinder car to be put into regular production, as an illustration of how a design may be selected to meet certain demands and how, when the initial factors are once selected, the entire design is immediately interlocked. The principle becomes more pronounced as machines increase in size and complexity.

In order to understand the reasons underlying this particular design, we must first know the objectives which were set for the finished car. The automobile of today has reached an almost phenomenal degree of perfection and practically all cars give reliable economical transportation with a really remarkable degree of comfort. A definite demand exists, however, for a large car capable of exceptional performance in traffic and on the open road, with supercomfort. Such a car could obviously only be available to a comparatively small market and all consideration of price could be removed from the design at the outset. To secure such comfort, a car must be large enough to give adequate room for seating without crowding and have sufficient sprung weight to give satisfactory riding qualities.

Both of these factors dictate a large heavy car. This car, to satisfy the particular market for which it was intended, however, had to have a greater acceleration, greater flexibility, and more satisfactory general performance than was formerly available. This, in short, was the problem confronting its designers; how to get performance in a large heavy car comparable to that of the smaller lighter cars available today which were considered to give exceptional performance but quite unsatisfactory riding qualities, too restricted space, and insufficient distinction for the type of buyer to which this larger car will appeal. The problem immediately resolves itself in a familiar law of physics $F = Ma$. The only solution can be to increase the force available for acceleration. The problem is complicated, however, by other demands of modern traffic.

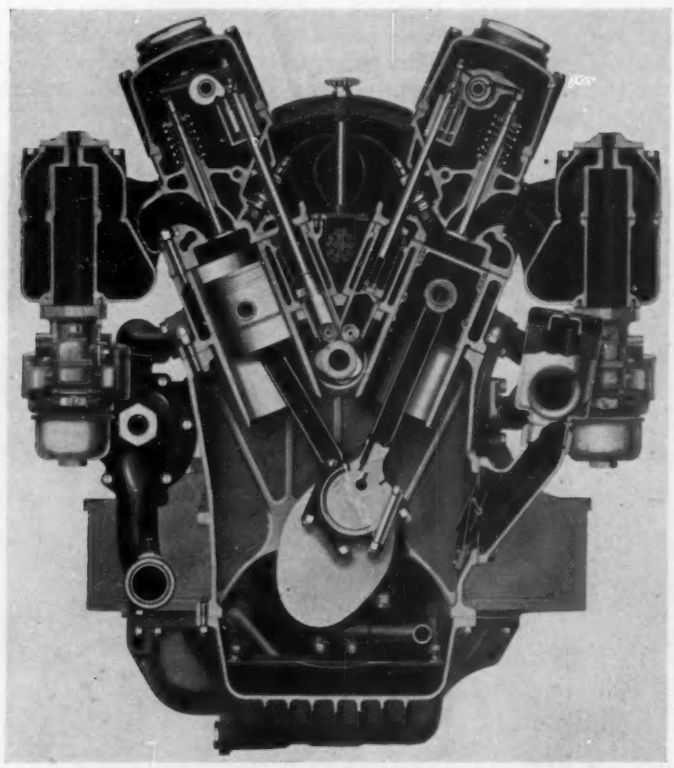
Acceleration must be available, not only at low speeds, but at high speeds in order that one may pass other cars going in the same direction at high speeds, a condition common on the highways of this country today. Higher speeds than those generally obtainable are also a prerequisite for such a car. But the resistance to be overcome at high speeds is largely that of air resistance and all the resistance encountered, that is, the total of head end resistance, rolling resistance, and the other atmospheric conditions such as skin friction and the vacuum effect at the rear of the car can be represented by a curve in which the resistance is approximately proportional to the square of the speed. This, in turn, makes the power required to drive the car proportional to the cube of the speed, a condition which obviously requires tremendous power if high speeds are to be obtained and if an adequate reserve power sufficient for acceleration at these speeds is to be provided. To be more specific, a seven-passenger sedan with a rear axle ratio of 4.75 : 1 will make better than 85 miles per hour and roadsters with an axle reduction of 4 : 1 will do better than 100 miles per hour, while great acceleration may be obtained at 60 miles per hour. These conditions necessitate a power plant of exceptional capacity.

The power output of an internal combustion engine is largely determined by its displacement. Greater power may be secured by making the cylinders larger, but this inevitably requires heavier reciprocating parts, reducing the speed of the engine and generally inducing vibration.

Greater displacement may also be provided by increasing the number of cylinders, thus securing the required additional power and at the same time obtaining a more continuous torque, smoother operation from more overlapping impulses and less stress on all rotating and reciprocating parts because of lighter impulses. This principle has been responsible for the present popularity of the eight-cylinder engine, for the gradual displacement of the four-cylinder engine by the six, and in turn the six by the eight.

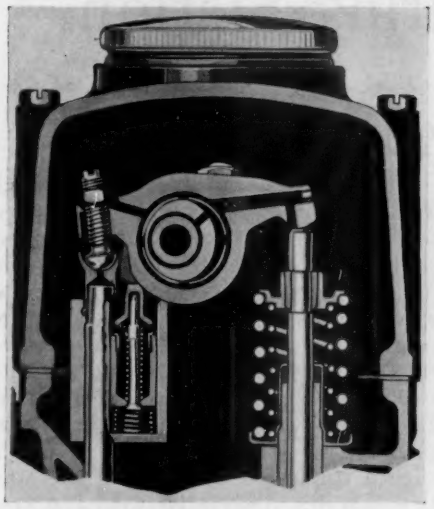
After a great deal of study, engineers finally decided on a sixteen-cylinder engine having a piston displacement of 452 cubic inches as most satisfactory for propelling this large car. The engine selected actually develops 175 brake horsepower with all accessory units in place and without the customary temperature corrections. This power is developed at a speed of 3400 r.p.m. and a maximum torque of 320 pound-feet is produced at 1400 r.p.m. The specific fuel consumption over the entire range of operation is approximately 0.6 pound per brake horsepower per hour.

A sixteen-cylinder engine would obviously have to be of Vee type construction to avoid excessive length and the many difficulties bound to occur with long in-line engines. The angle of the Vee is 45 degrees as this is the only angle which will give equally spaced power impulses. The angle of the Vee



CROSS SECTION OF THE NEW ENGINE

Among the features giving simplicity and compactness are the air cleaner and thermostat on the crankcase ventilation system; direct, efficient manifolding; and simplicity of valve action.



THE AUTOMATIC VALVE SILENCER

The tiny piston at the left of the photograph automatically compensates for all stem and push rod expansion caused by heat. The result is a quieter valve action.

is determined by the accepted formula

$$\theta = 360 \div \frac{n}{2}$$

where θ = angle of the Vee
n = number of cylinders.

The application of this formula gives 90 degrees as the correct angle for a Vee eight and 60 degrees for a Vee twelve. The bore selected was 3 inches with a stroke of 4 inches and compression ratio of 5.5 : 1, giving a maximum brake mean effective pressure of 160 pounds per square inch.

From these few general specifications dictated by the foregoing requirements of power and smoothness, the other factors of the design follow as a natural result, a striking illustration of the interdependence of design factors. With an included angle of 45 degrees the space within the Vee becomes too constricted to permit the use of an L head valve arrangement or the placing of carburetor and manifolds within the Vee.

Overhead valves were selected which in turn introduced another problem. This type of construction is generally subject to noisy operation which would be highly objectional and necessitated the development of automatic valve silencers which will be explained in greater detail further in this article.

The crankcase which forms a base for the entire power plant is cast from a silicon-aluminum alloy and is ribbed to provide greater rigidity and stiffness. Great care has been taken in its design to prevent resonance which would tend to amplify and telegraph minute engine noises to the interior of the car. It is closed at the bottom by a cast aluminum oil reservoir of ten quarts capacity provided with exterior cooling ribs and transverse interior baffles to prevent surging of the oil when accelerating and decelerating. A copper water passage is cast into the rear of the case to permit water to pass from the single water pump at the right of the engine to the left cylinder block.

The cylinder blocks are nickel-iron castings and again are of unusual design dictated by the factors we have already considered. In order to secure satisfactory appearance and pleasing body lines the engine must be made to conform to the prevailing contours of radiator shell and hood. This has been secured in spite of the added height above the piston necessitated with overhead valves by permitting the cylinder barrels to extend into the crankcase as seen in the accompanying cross-sectional view of the power plant. This also tends to give a greater rigidity to the entire engine. Another engineering feature of interest is the method of mounting the cylinders to the crankcase so as to relieve the bores of all stress. A row of studs and acorn nuts holds the cylinder blocks to the crankcase on the side away from the Vee. The opposite side of the block is secured by studs extending through the cylinder block and also through the cylinder head, clamping the block securely between the head and the crankcase without stressing the cylinder barrels.

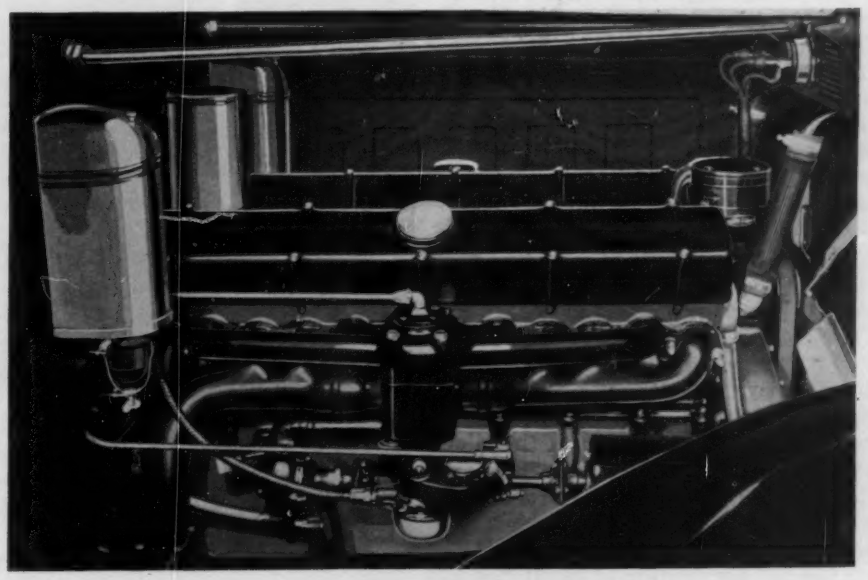
The design of the crankshaft was carefully considered so as to secure ample strength, freedom from torsional vibration and great rigidity. Five steel backed babbitt lined main bearings were adopted as it proved easier to lubricate five broad main bearings than a larger number of narrow bearings. Furthermore, five bearings are more than ample to prevent deflection; they permit a shorter engine where space is at a premium and also give sufficient room to permit removing any of the sixteen pistons and connecting rods without disturbing the cylinder heads. The total bearing length is 10 inches, which is approximately 25 per cent of the total length of the shaft. One of the most interesting features is the fact that the journals of the connecting rods overlap the main bearings by $\frac{9}{16}$ inch because of the unusually short stroke of 4 inches giving greater strength and rigidity. The main bearings are $2\frac{5}{8}$ inches in diameter, the connecting rod bearings are $2\frac{1}{2}$ inches in diameter, which with a crank throw of 2 inches gives the overlap already described.

The shaft is forged with crank throws in two planes giving inherent balance and is provided with four counterweights forged integral with the shaft. An harmonic balancer is provided at the front end of the shaft to completely dampen torsional vibration present in all shafts of more than four throws.

The connecting rods are chrome-molybdenum steel forgings with a center to center distance of $9\frac{1}{4}$ inches and a big end bearing $2\frac{1}{2}$ inches in diameter by $1\frac{1}{8}$ inches in length. The rods from opposite cylinders are placed side by side on the same crank throw, the blocks accordingly being staggered. The wrist pin bearing is a bronze bushing .75 inch inside diameter and $1\frac{1}{4}$ inches long. The big ends of the rods are lined with babbitt cast directly into the rod. Both ends of the rod are diamond bored to insure a perfect bearing surface.

The pistons are nickel-iron castings of light weight design, being used in preference to aluminum to avoid the difficulties of excessive expansion. Each piston is fitted with three compression rings and one oil control ring. The wrist pin is locked into the piston by a set screw preventing movement of the pin which might otherwise score the cylinder walls.

(Continued on page 416)



PERSPECTIVE VIEW OF THE NEW ENGINE

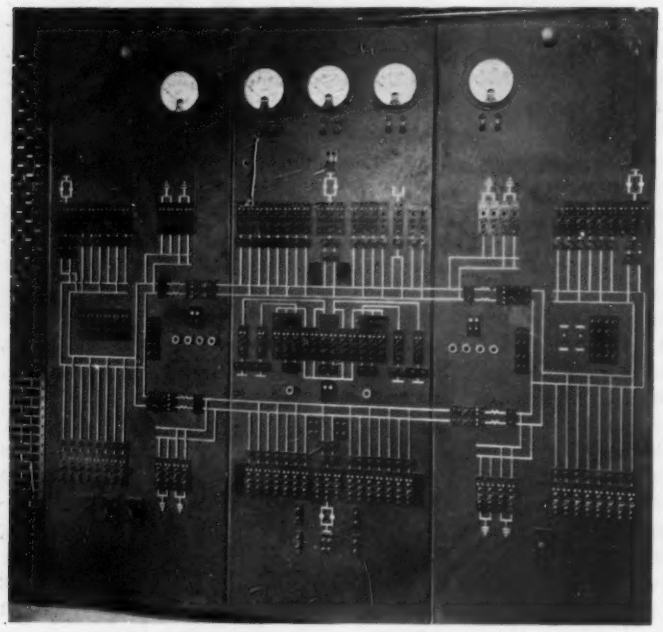
The dual delivery water pump, the two ignition coils, and one of the two fuel systems are shown here

Remote Control of a Distributing Station

A 12,000 K.V.A. power distributing station is metered and operated over telephone lines from a dispatching station several miles away

By F. ZOGBAUM
Electrical Engineering Department
New York Edison Co.

LATE in the summer of 1928, the New York Edison Company placed in service a new distributing station that is completely controlled and metered, over telephone wires leased from the local telephone company, from another distributing station that is about five miles away. The new station is located at West 238th Street and Spuyten Duyvil Road in New York City and the control station is at East 188th Street and Park Avenue.



SUPERVISORY CONTROL BOARD AT DISPATCHING STATION
From this board, a single individual can operate and meter a distant remotely controlled power distributing station

The new station houses transformer banks and switching equipment for controlling and transforming electrical energy received from the generating stations at 13,200 volts to the commercial lines at 2,300 volts. At present, the capacity of the station is 12,000 k.v.a., but the ultimate capacity is to be 24,000 k.v.a.

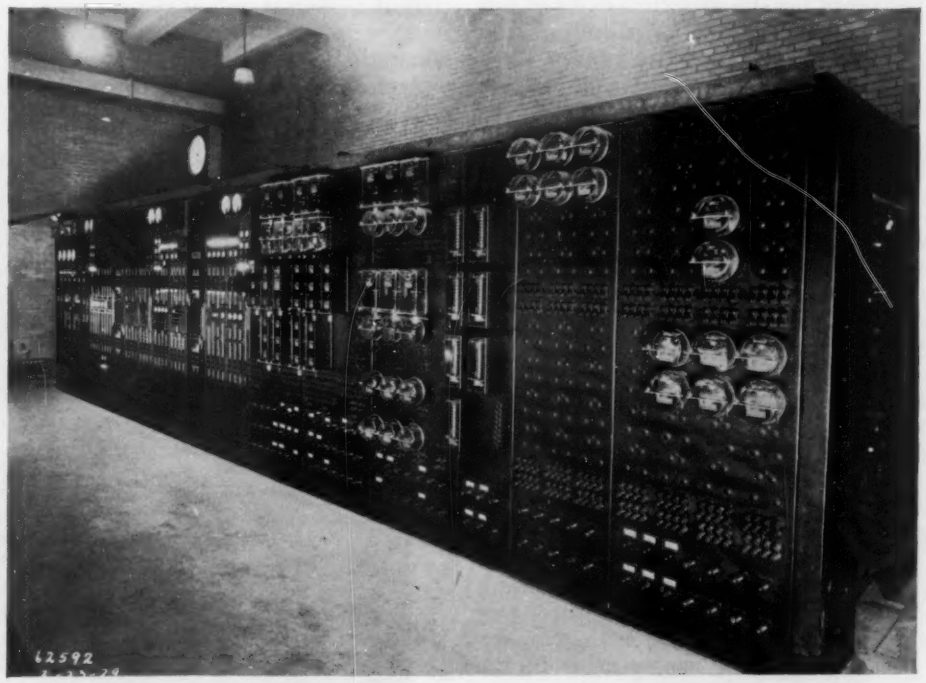
Save for occasional inspection, maintenance and lubrication, the operation of the station is accomplished entirely by mechanical and electrical means. All necessary adjustments and regulations during ordinary conditions of operation can be made from the dispatching station through the linkage afforded by the telephone connection. In order to bring this about, a high degree of ingenuity in design was required and the full application of latest developments in the field of electrical engineering.

To accomplish supervisory control and remote metering, a control board and relay chain have been installed at the remote station and at the dispatching point. The controlling medium is known as the synchronous relay supervisory system, designed in such a manner that each individual step in a sequence must be properly completed at both the power dispatcher's office and the distributing station before the next step may be taken at either station. This has been accomplished by the use of positive interlocks which prevent the control and supervisory circuits from being completed if the proper connections are not made at both stations.

The dispatcher's office is equipped with a number of small units representing each piece of apparatus to be controlled. These are provided with red and green capped indicating lamps which correspond to the closed or open position of the apparatus. An associated control key or push button and two white capped lamps and a stop key are also provided. These units are mounted in arrangements to conform with a single line diagram of the station layout. Associated with the key and lamp units are relay chain groups arranged for selecting the unit to be operated or metered.

At the remotely controlled station the relay chain equipment is essentially a duplicate of the relays at the controlling station. Interposed between the relay chain and the control equipment is a power type relay or contactor capable of operating the station equipment.

The first "group" relay, shown in the wiring diagram, may be considered as normally closed. The fundamental circuit consists of duplicate chains of counting relays called "register" relays which operate in synchronism, one locally and the other at the distant station. All relays are normally at rest. Pushing the start-button sets the relay chain in motion at both stations. The progress of the register counting is



CONTROL BOARD AT DISTRIBUTING STATION
Although the station may be operated from this board by manual control, it is ordinarily connected by telephone lines to another station, where, through a system of relays, its operations are controlled

maintained and checked for synchronism through the "drive" circuit by alternating from positive polarity for adjacent points of control. Since the point-to-point progress of the relay chain depends upon a circuit which is completed through each stop-key in turn, the relay chain may be stopped on any point, at the discretion of the dispatcher by opening the corresponding stop-key. The relay chain cannot proceed until the stop-key is restored to normal position.

With the relay chain stopped in this position, a direct metallic control and indication circuit is established between the dispatcher's control-key and indicating lamp, and the connected power apparatus in the distant station. The dispatcher now manipulates the operating key and master key as often as required. When the distant equipment has functioned, it furnishes an immediate return signal. If the dispatcher has no further immediate use for control at this point in the chain he restores its stop-button to normal, the "drive" and "register" resume their progress, carrying the channel of interstation direct wires from key to key until the next point of control is reached or to the end of the chain. The red and green capped lamp indications are verified every time the relay chain assigns the inter-station wires for an instant in passing on its way to a control or metering point.

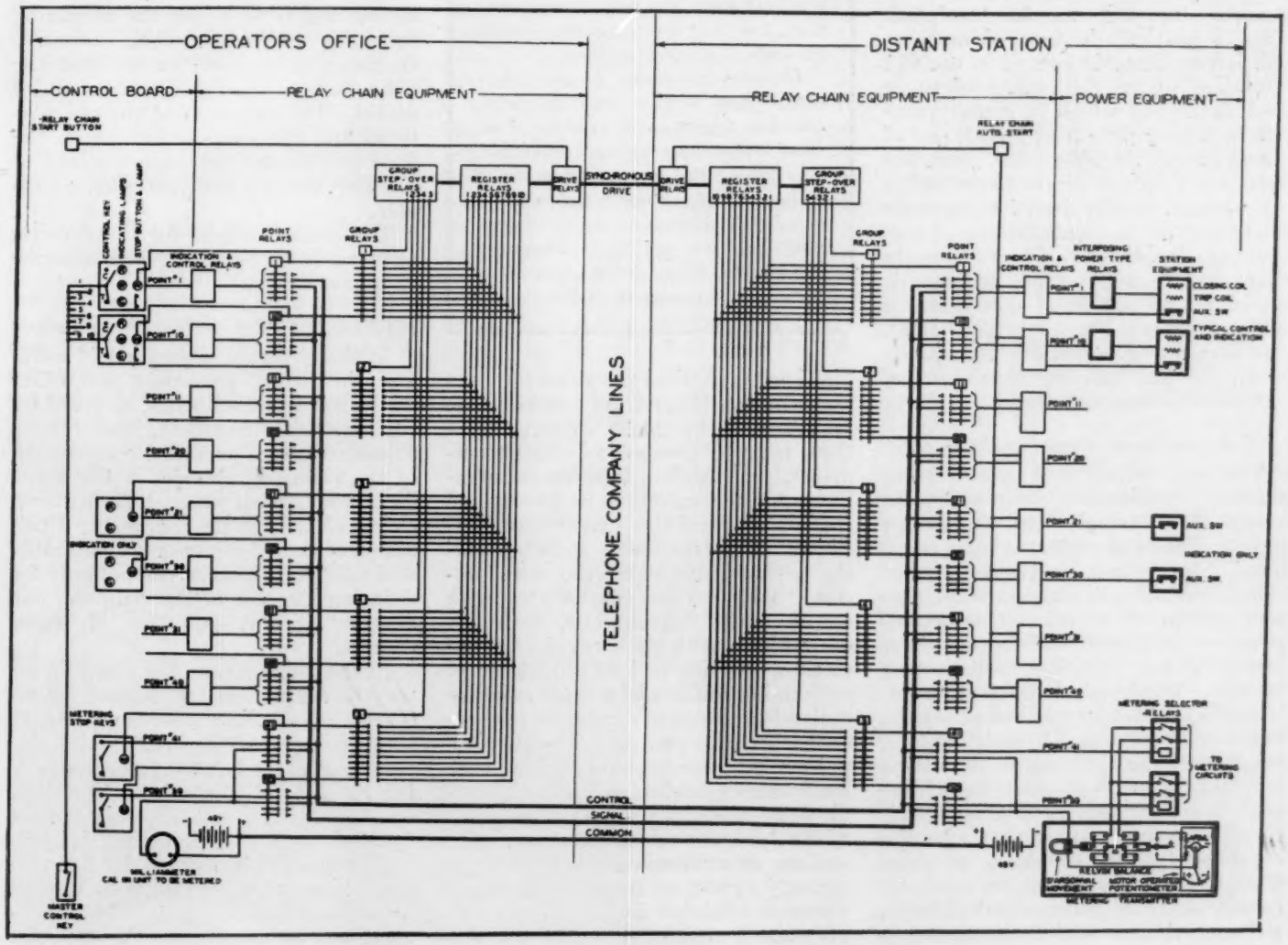
Should the outlying station equipment operate automatically because of overload, etc., the relay chain is automatically started and an audible signal is given. Its further action is then a duplicate of the ordinary starting initiated by the dispatcher. Since the associated control key is in the position of the last operation performed, it is evident to the dispatcher which piece of equipment has changed its position. When this disagreement between lamp indication and associated control-key exists a white capped "disagreement lamp" is lit at the key. By turning the control-key to the new position the dispatcher acknowledges the operation.

In order to avoid having an excessive number of "register" relays the equipment functions are divided into groups of ten. The "register" relays energize the point relays in regular sequence from one to ten through the first "group" relay. After point ten is

(*Continued on page 424*)

TELEMETERING TRANSMITTER

This instrument is used to measure the power being delivered through the remote control station and to transmit the information to the dispatching station.



WIRING DIAGRAM OF A REMOTE CONTROL SYSTEM

The lines of the local telephone company are used to transmit the electrical impulses which cause the relays to operate and control the distant station, performing its functions without the presence of human supervision

Chemistry as an Aid to Agriculture

The application of chemical processes to farm waste has meant dollars in the farmer's pocket

By H. P. Holman

Senior Chemist
Bureau of Chemistry and Soils
United States Department of Agriculture

THE term "farm wastes" brings to the mind of the layman those materials which are technically known as "crop by-products." These number among them the ligno-cellulose materials, such as straws, bagasse, cotton stalks, cornstalks and corncobs. We shall see how these products, formerly practically useless to anyone, have excited the attention of chemists, and how their experiments, some of which are still in progress, have resulted in the saving of many dollars annually.

Present Uses of Crop By-Products

Although some of the crop by-products are used as bedding, feed, fertilizer and fuel on or near the farms where produced, there is a large surplus above that which can be used advantageously for such purposes, with the result that some decidedly profitable industrial uses have been discovered for this surplus material. This is particularly true of bagasse, which was formerly burned in the wet condition under the boilers of sugar cane mills, but which in recent years has been made into fiber board; and of wheat straw, which for many years has been made into a crude paper called strawboard, largely used for egg-crate fillers, and in the manufacture of corrugated box-board. More recently there has been developed small-scale industrial utilization of cornstalks in making paper pulp, of wheat straw, flax straw and cornstalks in making insulation and building board, and of oat hulls in making furfural.

Composition of Crop By-Products

The crop by-products are somewhat similar in chemical composition to woods, the principal constituent groups in both classes of materials being celluloses, lignins and pentosans. Other constituents are sugars, starches, pectous substances, organic nitrogen compounds, inorganic substances, fats, resins, waxes, coloring matters and tannins. Of these constituents, cellulose, the skeletal material of all plants, is the most important to technologists, not only because it exceeds the others in quantity, but because the knowledge of its uses and methods of separation is more extensive than is that of other constituents. The celluloses, of which there are several varieties, are generally considered to be polymerized glucoses, although there is still disagreement as to their molecular structures. After being more or less freed of incrusting materials the cellulose fibers existing in most plant materials can be used in making paper and fiber board; and those from some plants, after being highly refined, can be used in chemical processes which yield valuable cellulose products, such as artificial textiles, plastics, lacquers and explosives.

Separation of Cellulose

Various chemical processes applicable to crop by-products as well as to woods have been developed and combined with physical processes for freeing cellulose fibers from non-cellulose materials. The most important of these may be grouped as alkali treatments, acid-sulphite treatments, alkaline-sulphite treatments, and combined chlorination and alkali treatments.

There are certain parts of the products of a farm that have represented a total loss to the farmer, for not only have they been valueless to him, but they have cost the farmer his time to dispose of them.

Organic chemistry, however, has made great strides since the war, and has found some uses for these wastes that have proved profitable. The problem of turning these waste celluloses into valuable materials is a most interesting one, and one that has not yet been answered completely. There is yet opportunity for research chemists in this field.

The alkali treatments include cooking with caustic soda (the soda process), with sodium carbonate, with caustic soda and sulphur, with hydrated lime, with mixtures of lime and calcium sulphide and with mixtures of sodium hydroxide and sodium sulphide derived from sodium sulphate (the so-called sulphate process). The acid sulphite treatments include cooking with a mixture of calcium sulphite and sulphurous acid (the sulphite process), with sulphurous acid solutions and with sodium or ammonium bisulphites. A recently developed treatment in which water and sulphur are used can probably also be classed with the acid sulphite treatments. The alkaline sulphite treatments include cooking with mixtures of sodium carbonate or hydrate with sodium sulphite, and with solutions of normal sulphites. In the combined chlorination and alkali treatments the material is subjected to the action of chlorine gas or solutions of chlorine or hypochlorite, followed, and sometimes also preceded, by treatment with alkaline solutions.

Less important methods, which do not fall into the above classification, are retting or treatment with enzymes, cooking with water alone or treatment with steam, cooking with solutions of neutral salts, such as sulphates, chlorides and nitrates, or solutions of mixed salts, treatment with phenols, and oxidation methods (nitric acid, potassium chlorate, and potassium permanganate). Few, if any, of these methods are used industrially at the present time.

Most of these treatments are intended to remove non-cellulose constituents completely, but some are designed simply to soften the incrusting materials or reduce their adhesive character to such an extent that the fibers may be separated by mechanical means. The character of the raw material and the purpose for which the fiber is intended determines which of the above-mentioned processes is suitable.

The usual method for decolorizing cellulose is by bleaching with chlorine or hypochlorites.

By-Products of Cellulose Manufacture

In the chemical separation of cellulose the lignin, pentosans and other non-cellulose constituents, modified by the chemical treatment, and humus substances from partial decomposition of the cellulose, are left in the spent liquors and wash water, together with chemicals used in the treatment. Utilization of these by-products is desirable and sometimes imperative, not only for reducing the cost of the cellulose, but also to prevent pollution of water courses.

In the soda process, the spent liquor may be evaporated and burned for recovery of alkali, the organic matter furnishing part of the heat required for evaporating the liquor. Upon leaching the sodium carbonate from the black ash, there is left considerable carbon contaminated with inorganic impurities. The most logical use for this material is as a fuel, although there may be a limited use for it as a black pigment and an absorbent. Caustic soda is regenerated by treating the soda ash solution with milk of lime.

The spent liquor obtained in treating

highly silicious raw material like straw can not be readily used for recovery of alkali because the sodium silicate present in solution combines with the lime used for causticizing and forms a bulky gelatinous precipitate which prevents settling and reduces the amount of soda that can be recovered. A process has been patented for removing the silica from the soda ash solution by precipitating with carbon dioxide or bicarbonate before causticizing.

Black liquor from the soda process can also be concentrated and subjected to destructive distillation, yielding methyl alcohol, acetone, aldehydes, amines, phenols, oils and tar and leaving a residue of alkali and carbon from which soda and impure carbon can be recovered. Acidification of the black liquor results in precipitation of lignin and humus matter having adhesive properties. This material can be used as a sizing agent, for the preparation of wood stain and brown or yellow coloring matters, as a plastic for preparing molded articles, or it can be subjected to destructive distillation to produce acetone, alcohol, etc. Sodium acetate can be separated from black liquor by concentrating, adding caustic soda and lime, charring at a low temperature and extracting with water. The solution is treated with carbon dioxide to precipitate sodium acid carbonate; acetic acid is added to neutralize excess of soda; and, after filtration, the solution is concentrated to the point of crystallization.

Black liquor from the sulphate process, which contains sulphur compounds in addition to compounds resulting from the alkali treatment, can be treated somewhat similarly to that from the soda process. The liquor is concentrated and burned, after which sodium sulphate sufficient to replace the alkali lost is mixed with the mass, which is then smelted, whereby the sodium sulphate is reduced to sulphide by the carbon present. The product is then dissolved and causticized with lime for reuse in cooking.

The humus matters in sulphate black liquor may be precipitated with carbon dioxide after addition of sodium chloride and subjected to destructive distillation. The alkali remaining in solution may be recovered as bicarbonate by the ammonia-soda process. Sulphate black liquor may also be evaporated with lime and caustic soda and destructively distilled in the presence of steam yielding fuel gases, acetone, alcohol, ketones, hydrocarbons, cresols, etc. The alkali and impure carbon in the residue can be recovered.

The principal organic constituents of waste liquor from the sulphite process are calcium and magnesium salts of lignin-sulphonic acids. In addition, there are sugars, organic acids, methyl alcohol, nitrogen compounds, pentosans, and free furfural. Numerous suggestions have been made on methods for utilizing these constituents. These include utilization of the waste liquor (preferably concentrated evaporation) as a binder for roads, briquettes, and foundry moulds and in conjunction with other materials for sizing paper; as a constituent of cattle feed (after special treatment); as a fertilizer by mixing with basic slag or other materials; as a raw material for the preparation of certain dyes and as a mordant and reducing agent in dyeing; for the preparation of lignin fuel with recovery of sulphur dioxide by adding acid sodium sulphate and heating; as a pulverized fuel after drying; as a liquid fuel after concentrating and emulsifying with fuel oil; for the production of acetone and other products by destructive distillation after recovery of calcium bisulphite; for the preparation of leather filler to be used in conjunction with tanning materials; and for the production of alcohol by neutralization, fermentation and distillation, with concentration of the fermentation residue for fuel.

BALED BAGASSE FOR USE IN FIBER BOARD
Each pile contains from 12,000 to 13,000 bales; the air spaces permit drying

STACKS OF BAGASSE AT THE SYRUP FACTORY
This picture will give an idea of the tremendous amount of waste material left by the sugar industry

In addition to the waste materials left in the liquor used for treating ligno-cellulose materials for the separation of cellulose, there are also volatile materials in the vapors released from the digesters which should be recovered if they have industrial value or disposed of if they have no industrial value and their discharge into the atmosphere is a nuisance. The relief gases from the soda process contain methyl alcohol and possibly volatile oils. In the sulphate process the relief gases contain, in addition to methyl alcohol and volatile oils, organic sulphur compounds which give them a very disagreeable odor. In order to eliminate odors special condensers, oxidizing agents and absorbents can be used, or the gases, separated from entrained liquid, can be burned by passing them under a furnace grate. The relief gas from sulphite digesters contains much sulphur dioxide, which can be largely recovered by absorption for re-use in the process. The condensed vapors may also yield methyl alcohol, acetone, aldehydes, and oils (largely cymene when spruce wood is used).

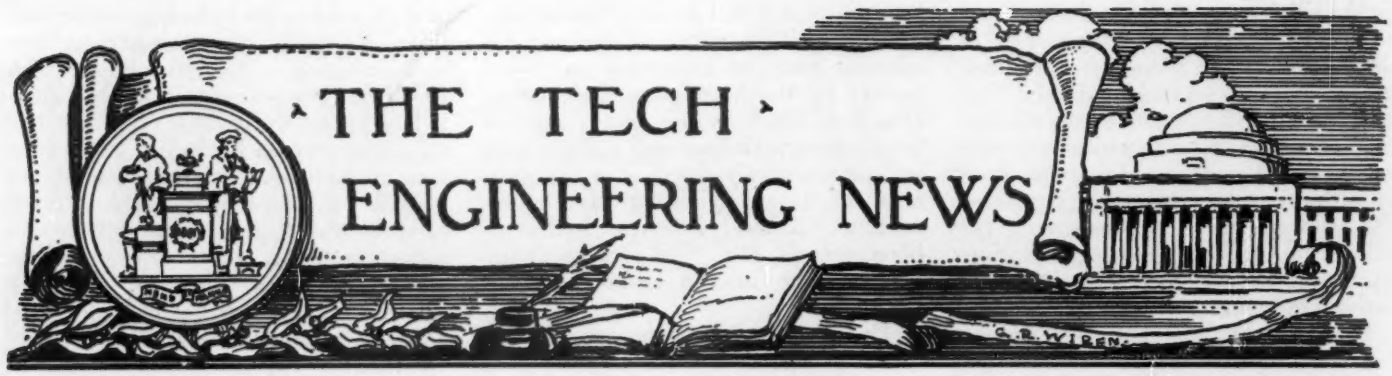
Lignin

After cellulose, lignin is the most abundant and possibly the most important substance or group of substances in crop by-products. Much work has been done on the chemistry of lignin, but much remains to be done. It appears that the term "lignin" includes a group of substances, the chemical composition of which varies not only in different species of plants but also in different parts of the same plant. The chemical structure of no lignin substance has been definitely determined. According to Schorger,* furan, benzofuran, pyrone, benzenoid, and aliphatic structures have been proposed. It has been definitely established that lignins contain aromatic nuclei and methoxyl and hydroxyl groups, but the presence of ketonic, acetyl, and aldehydic groups has not been satisfactorily proved, and the presence of formyl and carboxyl groups is doubtful. It appears that lignin is modified by all methods employed for its isolation, which would account for the lack of agreement of various investigations on its constitution and properties.

Lignin is very resistant to the action

(*Continued on page 426*)

*"Chemistry of Cellulose and Wood."



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Editorials

THE OLD ORDER CHANGETH

WITH the publication of the January issue and the passing of the Managing Board of Volume X, the first decade in the history of THE TECH ENGINEERING NEWS comes to a close. Ten years ago the magazine was founded as a supplement to *The Tech*, the undergraduate news organ. It soon established itself, however, as an independent publication and by its growth it has justified its existence and position as one of the foremost student activities. The days when the sponsors of the paper were faced with continual emergency which threatened the very existence of the publication seem long ago.

During the past year, it has constantly been the editorial goal to publish a magazine which would have a definite personal appeal to the individual reader. With this in view, the series of Faculty Sketches was inaugurated, and the section of "Among our Authors" is intended to further develop a spirit of personal interest in the material of THE TECH ENGINEERING NEWS. We have tried to present articles which carried with them not only the merit of technical value, but also the features of artistic illustration, readability, and timeliness. Recognition of our editorial efforts has been received in the awards for the best single editorial of the year, third best cover design, and third best illustrations in the competitions at the annual convention of the Engineering College Magazines Associated.

Rarely in contact with the individual reader, and never in a position to speak for itself, the Business Department has made great progress during the past year. The circulation, advertising and publicity staffs have worked unceasingly to fulfill their responsibilities. Their efforts have made possible the purchase of several needed office appliances, as well as the replacement of a number of antiquated desks by furniture of modern design, and the financial condition of the paper has been maintained on a sound basis.

In an endeavor to be of service to the Institute, a calendar was published this fall by THE TECH ENGINEERING NEWS, of which three thousand copies were distributed to the student body and staff. Its attractive design and general utility brought forth much favorable comment, and we feel that it helped to increase our share of good will on the part of Technology as a whole.

As in the case of our predecessors, the Managing Board of Volume X now completes its term of office. The seniors leaving take with them a wealth of friendship and association that has made the years of activity life at Technology worthwhile. Three of the juniors have been selected to carry on the work of directing the policies of the magazine during the coming year. It is to them and their associates that we entrust the traditions and future of THE TECH ENGINEERING NEWS. In leaving, our sincerest congratulations and best wishes for success go to the incoming Managing Board of Volume XI: *General Manager*, Richard T. Kropf '31; *Editor-in-Chief*, John H. Dodge, Jr. '31; *Business Manager*, Christian E. Grosser '31; *Managing Editor*, E. Harold Anderson '32; *Associate Editors*, Albert G. Dietz '32 and Clarence M. Chase, Jr. '32; *Advertising Manager*, Richard M. Stewart '32; *Circulation Manager*, Allan M. Maguire '32; *Publicity Manager*, Peter P. Shelby '32.

TEACHER VS. TEXTBOOK

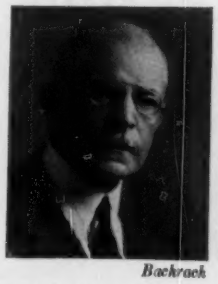
ONE of the greatest factors in the progress of engineering is the proper education of the men about to enter the field. The Institute, recognizing this fact, has spent considerable effort in improving the educational methods it employs. Studying the situation at the present time, modern educators have come to the conclusion that one of the most glaring faults in our present system is the great gap that exists between preparatory school and college.

Perhaps the greatest difficulty the new student has to face when he enters college is the difference in methods of teaching. In preparatory school he has been accustomed to rely almost entirely upon his teachers. He has had most of his work explained to him orally. If there was some point he did not understand, he asked a question, and it was answered. His was a passive education. In college he finds the greatest emphasis laid on the textbook. He must learn things for himself, work out his own methods of solution. His instructor exists not as a teacher, but as an interpreter of the text. His education has become active.

This method seems to be a fixed point in Technology policy, and it is doubtless a very valuable one. It is intended to prepare the student for a job where there will be no teacher to answer his questions. It is training for an almost indispensable part of an engineer's make-up, the ability to figure things out for oneself. No student can hope to succeed in engineering unless he has learned to do so. Does this mean, however, that the gap between school and college is inevitable? In our opinion, it does not.

The real trouble seems to lie in the fact that the change is so abrupt. The freshman, bewildered by the newness of his environment, is unable to master this self-teaching at once, and as a consequence, he loses many fundamental, and therefore doubly important, concepts of the first year's work. His foundation in mathematics, chemistry, and physics, upon which many of his strictly professional courses in the junior and senior years depend, is weak because of a hazy conception of the facts, and later work must suffer because of this.

Would it not seem advisable, then, to make the change in methods of teaching more gradual? If freshmen were taught more and required to learn less by themselves, for the first few months, at least, of their engineering education, would not they themselves, their school, and their profession greatly benefit? It is only by raising such a question, by answering it intelligently, and by acting on that answer, that we can make progress. Which shall it be, Teacher or Textbook?



Backrack

PROFESSOR WALDEMAR LINDGREN

One of the foremost geologists of this country, with a world-wide reputation, is Professor Waldemar Lindgren, Head of the Department of Geology. Although he has done much outside geological work, he also has built up the Department of Geology during his seventeen years at the Institute so that it is now a well-known school, especially for advanced students.

Born and educated in Sweden, he studied for five years at the Royal Mining School at Freiberg in Saxony, from which he received his degree as Mining Engineer in 1883. He then came to America, and until 1912 was a member of the staff of the United States Geological Survey. At first he was an Assistant Geologist, and it was at this time in the early '90's that he made his intimate acquaintance with President Hoover, who worked as his assistant on geological trips in the Sierras during college vacations. The story of these days is told by Professor Lindgren in the article, "A President in the Making," appearing in THE TECH ENGINEERING NEWS for March, 1929. In 1898, he was appointed to the Faculty at Stanford University. Later, in 1912 he resigned from the Geological Survey after having attained the position of Chief Geologist, and came to M. I. T.

As William Barton Rogers Professor of Economic Geology, Professor Lindgren has always devoted much of his time to economic geology, particularly to mining geology, although he has also done much work in the fields of general geology and petrology. Also, for a few years, he served as Head of the Department of Mining and Metallurgy.

During his long professional career he has visited and reported on ore deposits in most of the states of the Union as well as in Canada, Alaska, Australia, New Zealand, South America, Cuba and Mexico. His principal aim in these reports has been to apply a thoroughly scientific treatment to the problems of ores and mineral deposits. In 1927 and 1928 he was in charge of the geological section of the National Research Council in Washington. Just recently he returned from a month's tour in Sweden and other northern European countries where he discussed ore deposits with some of the leading geologist of Europe.

Among his writings Professor Lindgren is the author of "Mineral Deposits," now in its third edition, many reports on important mining districts published by the United States Geological Survey, and about a hundred articles on other scientific subjects. He is also one of the editors of the *Journal of Economic Geology*.

An honorary degree of Sc.D. was conferred upon him by Princeton in 1926, and in 1928, Professor Lindgren received the Penrose gold medal for geological work. Besides being a member of the National Academy of Sciences, the Academy of Arts and Sciences, and the Washington Academy, he is a member and former vice-president of the American Institute of Mining and Metallurgical Engineers, and a member and at one time president of the Mining and Metallurgical Society of America. He is also a corresponding member of three European geological societies.

CREATIVE THINKING

ONE of the most inherent of human desires and instincts is the longing for success, the desire to stand out as a leader in one's chosen field. However, in order that some may lead, many others must serve as followers in the ranks. What is it that differentiates between these two classifications? Certainly it cannot be measured in terms of physical ability, for the unskilled laborer is more than a match in strength and muscular control for the modern executive. Clearly, the distinction lies in the realm of mental activity.

There are several different aspects of mental activity that may be considered, such as the ability to imitate, the applying of certain fixed and definite methods to certain limited problems, and the ability to do creative thinking. It is quite evident that the first two qualities are those of the followers, while the last, the ability to engage in creative thought, is an attribute of those who stand out as leaders.

Thinking is, in itself, the arranging and collecting of certain conceptions and ideas in different ways. To think creatively is to make this arrangement and collection productive in a new way.

During our undergraduate years, we are presented with remarkable opportunities to develop this form of mental capacity. Our courses are varied, and in rapidly shifting our line of thought from physical chemistry to electrical engineering or hydraulics, we can obtain a freedom and freshness of thought that inspires creative thinking to a high degree. The way in which subjects are presented, with much of the burden of instruction placed directly upon the student himself, makes this kind of thinking almost a necessity to scholastic success. Then too, there is always the opportunity, through individual interest, to carry one's thinking further into the subject than the ordinary routine of instruction may go.

If, following graduation, we wish to have responsibilities which depend upon our ability as creative thinkers, we must begin today to train ourselves along this line, to develop originality and initiative in our mental processes, that we may truly qualify as leaders in our chosen fields.

THE COVER

THE penstock and machine houses of the Loentsch hydroelectric power station in northeastern Switzerland is the subject of the cover illustration for January. Water is drawn from Lake Kloental, and the huge rock wall in the background gives some idea of the head of 1,120 feet. Eight Pelton turbines are used to supply the maximum capacity of 66,000 horsepower.

The Engineering Field

Abstracts from the leading professional and trade journals

A 4,000 Horsepower Racing Car weighing only 5500 pounds is being built to attack the present speed record.

The unique features of the new model are the reduction of air-resisting surface area, and the design and arrangement of the power plant. Better streamlining is attained through continuous symmetry along the longitudinal axis, the only break being a slight rise at the cockpit. Radiators are eliminated by the use of a double "skin" of aluminum through which water and oil is circulated by pumps. Width is reduced by closing up the usual 60° V angle between the banks of cylinders to 45°.

The power plant consists of two water-cooled, twelve cylinder, narrow V supercharged engines, which are fitted in tandem and drive each rear wheel through two propeller shafts. The driver, placed between the two shafts, sits only about eight inches above the ground, thus securing reduced head resistance. The maximum height is but forty inches. The two engines, entirely separate, have crank cases and cylinder blocks of aluminum. The cylinders, cast in blocks of three, are fitted with nitralloy steel linings. The crankshaft, also of nitralloy steel, is carried in seven roller-bearings, and lubrication is maintained by three pumps. Valve seats are of bronze and are cooled by oil jackets. The superchargers make possible an engine speed of 4000 r.p.m. which is geared up to a drive shaft speed of 7000 r.p.m.

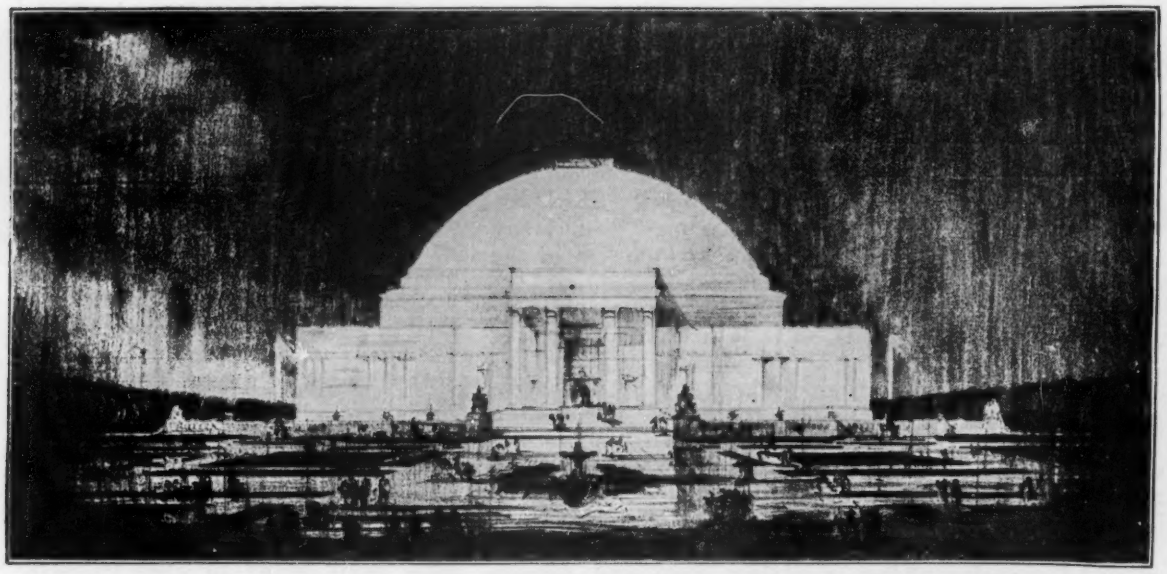
The thirty-seven-inch tires are an advance on anything previously built, the foundation being of silk, and the rubber being sprayed on. Used with a lighter car they should contribute effectively to breaking the record.

Concrete Railway Roadbeds have been installed in a test project, near Detroit, Michigan, in an attempt to secure increased speed for railway trains, with smoother and more comfortable riding. The rigidity of the new roadbeds is said to prevent sagging of the rails under the wheels of passing trains, thus offering less tractive resistance than the usual roadbed now in use.

The new roadbed is made of concrete slabs, each 19 feet, 6 inches long and 9 feet wide and weighing 15 tons. The slabs may be pre-cast, cured and transported to their desired location, where they are fitted together with tongue-and-groove joints extending their full width.

Girders to support the rails are cast with the base slabs. Transverse girders are placed across the slabs, at intervals of six feet, between the rail girders, the spaces between them being later filled with ballast.

Adjustable two-inch bolts, set at an angle in steel bars embedded in the concrete base slabs, are used to fasten the rails. At the bottom of each bolt is a cast shoe slotted to bear against the base of the rail. Simple adjustments of the bolts provide precise rail alignment.



Courtesy *Scientific American*

THE NEW PLANETARIUM FOR CHICAGO

The architect's sketch for the planetarium which has been erected on an island near the Field Museum in Chicago. Great interest has been taken in this new scientific development

A Planetarium fad which started in Germany several years ago has aroused much interest and enjoyment in science among non-technical people in the United States, especially in Chicago and Philadelphia.

A planetarium is a controlled mechanical reproduction of the universe, showing the heavenly bodies and their paths through space. The mechanism is housed in a hemispherical building, the dome of which represents the sky. The 5400 stars normally visible in the heavens on a clear night are represented by spots of light projected from an odd-looking apparatus in the center of the floor. The mechanism holds 119 optical projectors and 16 lenses set in various positions on the sides. Behind each lens is a kind of diaphragm bearing each star in its proper position. The concavity of the lenses takes care of any discrepancies, such as blurring and overlapping of images. To control the motion of the stars, an electric motor rotates the helmet-like set of lenses. All operations are controlled by means of a bank of push-buttons on the desk of the speaker.

The planets are also shown. As their speed varies, both in regard to each other and to the stars, each body has a separate motor, synchronized to one another so as to give a realistic effect. The 24-hour day may be run off at any desired time.

Spectators may also shift their points of view, not only in space but in time. They can retrace their steps fourteen thousand years, or can jump ahead several thousand years. It is possible to jump from Berlin to Chicago, from the North Pole to the South simply by shifting the position of the "star-projections." The planetarium makes it possible to take the solar system to pieces, and thus to gain an intimate knowledge of all celestial movement.

Special Airport Surfaces are being studied carefully in an effort to improve runway conditions. The old sod-surface runway for airplanes has been discarded for a more durable and

useful coating. Special considerations, such as the heavy loads carried by modern planes, and the resulting strain on the runway during the take-off and landing have made it advisable to surface them with coatings suited to their needs.

Surfaces on runways are now classified in four groups: the earth and sod type, the "low," intermediate, and "high" types, ranging from the natural sod to a complete concrete reënforced floor. The so-called "low" type consists of selected soil, gravel, cinders, or crushed stone; the intermediate type of a hardened surface of some such material as asphalt mixed with the soil, and the "high" type surface, usually constructed of concrete, reënforced and covered in some instances with a wearing coat of sheet asphalt.

The increase in the use of air transportation has put a heavy burden on landing fields, especially those located near large cities. As a result, it is becoming increasingly apparent that a "higher" type of runway must be constructed and maintained. Though the first cost of the concrete type is quite high, it is rising in favor over the less expensive types because of its great durability, freedom from dust, and easy visibility from the air.

The Use of Terracing to combat soil erosion losses is the subject of a study being made by the United States Department of Agriculture. Due to the fact that losses from the erosion of soil in a single year amount to ten million acres, costing the farmer many millions of dollars, the Department is carrying on extensive research for preventive methods. After considerable experimentation it has been decided that the use of terracing, or building up the surface of hillside land in the form of stairs, is the most effective protection.

It was found that erosion of the soil, chiefly due to the free movement of water over the ground surface, injures the fertility of the soil in several ways. Not only are the upper fertile parts of the land washed away by the unrestricted water flow, but this transported soil often settles on other valuable ground and renders it useless. Gullies are dug, and at the same time drainage ditches are filled by the action of the water. All classes of farmers whose farms lie in unprotected areas are liable to loss, since their useful land may be either covered over or washed away. Of the many methods available to prevent this free motion, the use of terraces has been found to be most permanently useful.

The terraces used in the field experimentations were of two types: a "bench terrace," consisting of successive platforms of earth banked one upon the other, and the ridge terrace, which consists simply of ridges thrown across the hillside. A terracing machine which will greatly aid the farmer in his construction has been developed in the course of the investigation.

Courtesy *Engineering News-Record*

RIDGE TERRACING

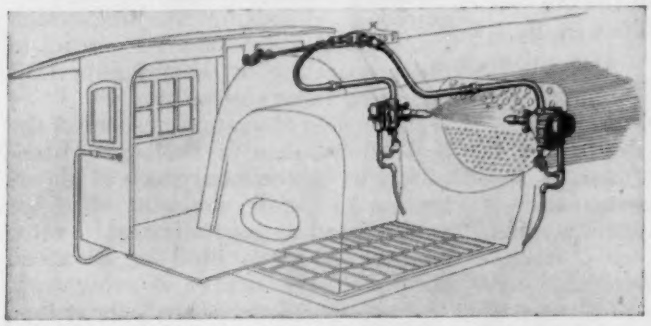
The ridge terrace consists of ridges thrown across the hillside. Water flows off in the broad, shallow channels, preventing erosion

Acoustic Depth Sounders bringing two new refinements have been perfected in experiments conducted off the coast of California. Intensive experiments carried out during the World War in detecting submarines have been crystallized in these new devices.

Both, operating on the same principle, consist of an oscillator located at one end of the battleship and a microphone situated at the other end to detect the echo of the pulses sent out by the oscillator and reflected from the bed of the ocean. A constant speed motor sends out sound pulses at definite intervals of time. These pulses are caught directly by the microphone and again when the echo comes from the bed of the ocean. The interval of time between the recording of the two pulses is a measure of the depth of the ocean at that point.

In one type the microphone closes circuits which send out trains of electric sparks when the pulses are received. These sparks are passed through appropriately graphed paper to record the depth directly. The other type controls an indicator which shows the depth on a dial. The former type is used for charting while the latter is useful in navigation. Both possess the distinct advantage of being usable when the ship is moving at full speed and give a large number of readings in a short interval of time so that the topography of the bed can be accurately ascertained in a short time.

A Soot Blower for locomotives now eliminates cleaning of flues and combustion chambers at terminals. It is operated by the fireman and is used for three minutes after every one hundred miles of passenger travel. When the steam which operates the device is admitted by valve control, a fraction of the steam starts a small turbine. This in turn oscillates two nozzles, placed at different positions, which blow the rest of the steam over the entire surface of the flue sheet and combustion chamber. The nozzles traverse the whole area six to eight times per minute. The apparatus, which is enclosed, is entirely automatic with the exception of the valve control necessary to put it into operation.



Courtesy *Locomotive Cyclopedia*

SOOT BLOWER

The diagram shows the nozzles which blow the steam over the flue sheet and combustion chamber of the locomotive

A Concrete Arch of Unusual Design has been used to eliminate a dangerous traffic condition in California. It is an open spandrel type in which the columns have a curved alignment and are supported on wide arch ribs. The new alignment includes a curved bridge, 1200 feet of new location, and replaces the two-span underpass with a single 75-foot railway span.

Pairs of spandrel columns are spaced 15 feet apart with centers along the curve, which has a radius of 400 feet. The height of the roadway is 72 feet above the stream-bed and the deck is composed of a 24-foot roadway and two 4½-foot sidewalks on 10-inch curbs. The roadbed is protected by angle iron and all joints are left open one-quarter of an inch for expansion. The two column bends on the arch and in the approaches are parallel and are at right angles to the center line between the arch ribs. Instead of a structure with columns in a straight line and sidewalk brackets of variable length, the design described above has been adopted

Departmental Notes

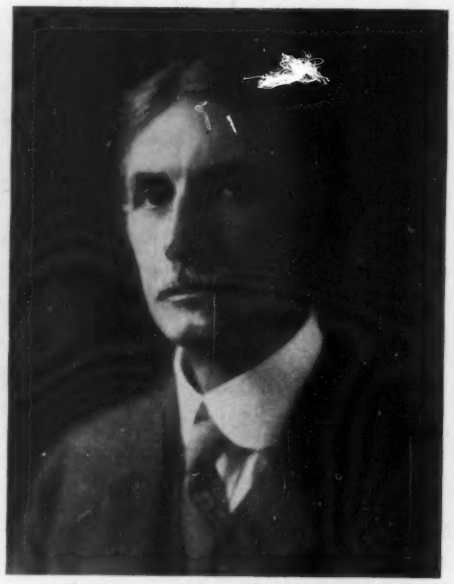
DEPARTMENT OF BUILDING CONSTRUCTION

THE course in Building Construction is gradually taking its place among the larger engineering courses of the Institute. Although only in its fourth year, it now has an enrollment of one hundred and two students.

In June, 1929, it graduated its first class, a group of eight men, all of whom immediately found employment with important firms, and, so far as information has been received, are doing well. In fact, one of them, the holder of the Horowitz Scholarship, is acting superintendent on a large building operation in New York City. Inasmuch as such a position demands a thorough knowledge of the details of building, the fact that this young man, hardly five months after graduation and with no previous experience in building, is competent to assume the responsibility that such a position entails, is a favorable commentary upon the value of the technical instruction imparted by the course.

By way of explanation, it may be of interest to know that the Horowitz Scholarship, mentioned above, is awarded each year to one of a group of the leading five or six men of the graduating class. This scholarship provides for two years' employment at a salary of fifty dollars a week with the Thompson Starrett Company, one of the largest of our building organizations, and it further provides that the holder of the scholarship shall rotate from department to department in order to acquire a knowledge of the functions of each, and the relation of each to the others in the control and erection of a great structure or a number of great structures, built under conditions where time as well as good workmanship are dominant considerations.

The feature of the course, in which it differs from other engineering schools, is the special training in the mechanics, or assembly of the materials of building that the student receives. It is quite as important for the engineer builder to know how to set a window frame in a masonry wall, so that it will be weather-tight, how to set stone and architectural terra cotta, how to make roof connections weatherproof, and how to coördinate and direct the thirty or more trades and crafts that have to do with the assembly of a building structure, as it is for him to be able to check the rivets in a steel connection, or the bars in a reinforced concrete girder or the size of a wooden column in a timber mill. As a rule, the young engineer and architect graduating from our technical schools is without the knowledge of such details and he is obliged to spend some years in unremunerative employment in order to acquire this knowledge, and even then, he is very likely to learn only the "hows" of things instead of the "whys" of things.



PROFESSOR ROSS F. TUCKER
Professor of Building Construction

The objective of Course XVII is to shorten this period of unremunerative employment, as well as to raise the status of building from a trade to that of a profession, and while it is as yet too early to appraise its value with the certainty derived from actual performance, the indications are, to date, that it will be highly successful in accomplishing what it has set out to do.

It might be pointed out also that the preparation given by the course is adequate, not only for the business of building, but for many other occupations having to do with the manufacture and distribution of the materials and appurtenances of building, as well as for collateral professions such as architecture, banking and the law.

R. F. TUCKER '92.

DEPARTMENT OF MATHEMATICS

THE work done in this department is little known to the average student, since advanced mathematics is not easily understood by the layman. There are four broad fields, mathematical physics, analysis, geometry and algebra, that the men of the staff cover in the many papers which are presented at the meetings of the American Mathematical Society and published in the various mathematical journals of this country and Europe, including "*The Journal of Mathematics and Physics*," published quarterly by members of the Institute staff. Established eight years ago, this journal has done much to promote research among the men of the department.

In the field of geometry of more than three dimensions, much work has been done by Professor Moore; and Professor Struik, who is also interested in hydrodynamics from the mathematical point of view.

Professor Franklin is very versatile in his handling of mathematical problems. He is the author of many papers covering geometry, algebra, calculus, analysis, situs, and the four-color problem. In spite of the apparent simplicity of the four-color problem it has many and varied difficulties. He has developed in conjunction with Professor Wiener the subject of almost periodic functions. The latter has done some other work of world-wide interest.

Important contributions have also been made by Professor Wiener to the complete solution of the historic Dirichlet problem connecting the boundary conditions of an electricallycharged mathematical plate with the interior potential.

Last year, Professor Wiener did some very important work on the prime number theorem, which concerns the percentage of prime numbers that are met as the numbers increase indefinitely. There is a certain fixed but complicated relation regarding this occurrence of prime numbers after the number has increased sufficiently. Extra proof was given to the main theorem by the special work that he did in proving an auxiliary theorem independent of the main one. Mathematicians had been using this Tauberian theorem for a hundred and fifty years but they had not believed it capable of independent solution. He is lecturing one day a week at Brown University on this and allied subjects.

The department has recently acquired a computing machine which Professor Rutledge has been using in the preparation of several important papers on interpolation.

In the field of quaternions, one of the best known men is Professor Hitchcock, who has devoted much of his attention to the development of vector analysis and its generalization. Vector analysis is much used in advanced theoretical electrical engineering work.

Problems of interest to mathematical physicists and mathematicians are regularly discussed at weekly meetings

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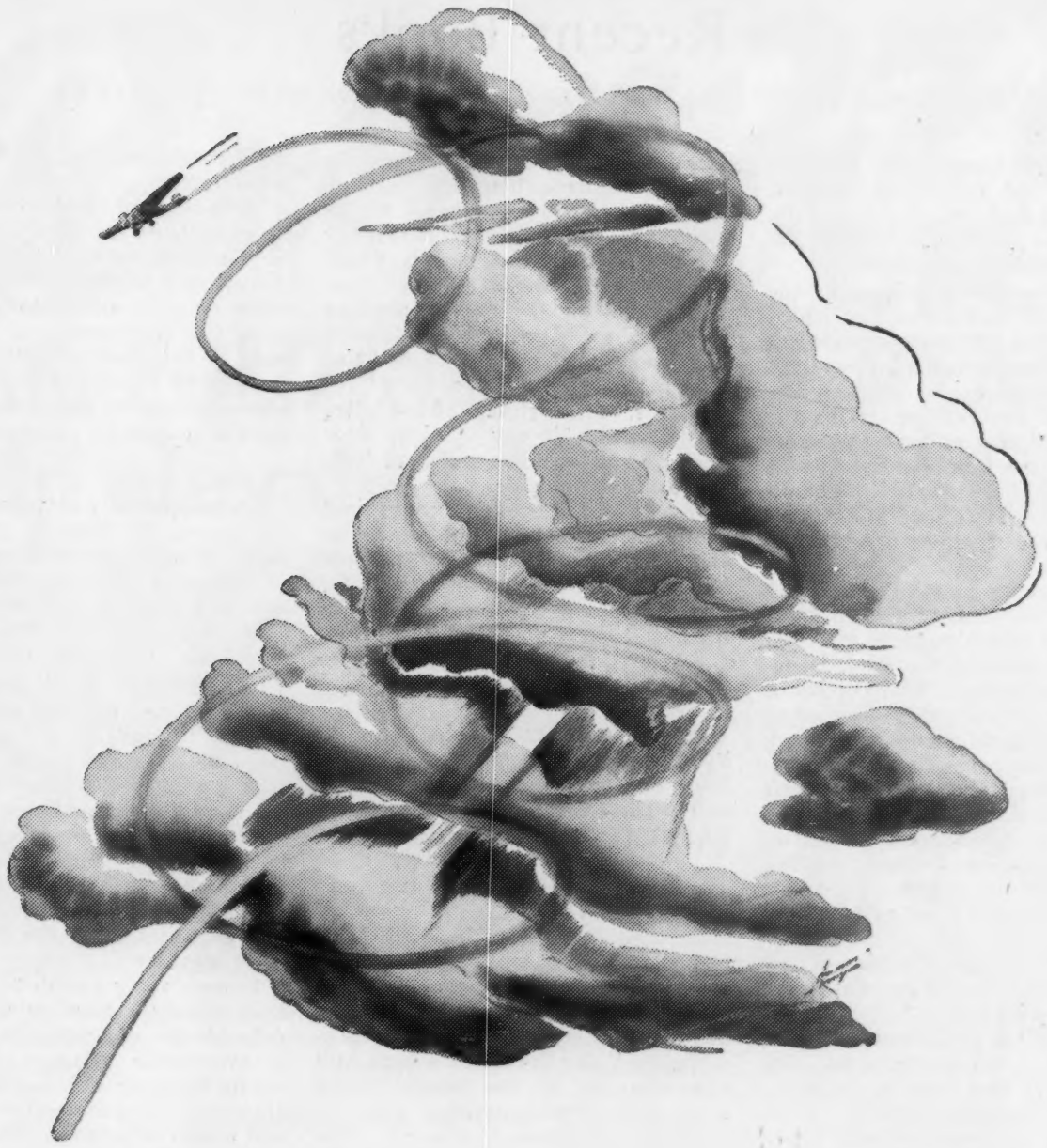


No compass to guide him

Trying to pilot a plane without compass or other instruments is as unsatisfactory as trying to pilot your course through life without a plan.

You find many a man after college switching from job to job—"I think I'll try fiction writing for a while," or "Selling bonds is what appeals to me." Aimless! Real progress does not come in that way.

Fortunately most men have a natural aptitude for one type of work rather than another—for things mechanical or artistic, factual or imaginative. The solution of the problem is to be found in self analysis, making a decision and then following through.

Western Electric

SINCE 1882 MANUFACTURERS FOR THE BELL SYSTEM

Recent Books

This department conducted in co-operation with the faculty

The Aircraft Handbook. *By* FRED H. COLVIN *and* HENRY F. COLVIN. *McGraw-Hill Book Co., New York City. Fourth edition, September, 1929. XI, 690 pages. Illustrated. $5.00.*

THIS is the fourth edition of the Handbook, which was first issued in 1918. It was originally intended as a manual on maintenance and repair of airplanes for the use of airplane mechanic, pilot or operator. With the appearance of new editions, the scope of the book has been somewhat widened, but it still is essentially a handbook of practical information for those engaged in the repair or operation of airplanes.

Since the engine constitutes the most elaborate mechanism of the airplane, and the one which requires most attention, one-third of the book is devoted to this subject. This portion of the book comprises a very brief introduction applying to engines in general, followed by 200 pages devoted to service instructions for various popular types. This material is largely borrowed from the handbooks issued by the manufacturers of these engines. The final section devoted to engine "trouble shooting" is rather well handled.

There are so many airplanes now manufactured in the United States that it would be a large undertaking to describe them all in detail and to include service instructions for each type. The authors dodge this issue by including very brief descriptions with photographs of a few representative types, together with a brief chapter of instructions for rigging and servicing airplanes in general. It would seem to the reviewer that the material on the airplane itself might be expanded to be more in proportion to the space devoted to engines.

In addition to the sections devoted to airplanes and engines, there are chapters devoted to propellers, instruments and accessories, materials, airplane construction, airports, air commerce regulations, and nomenclature. There is also a brief but interesting chapter on airships and dirigible balloons. With a few exceptions, the descriptive matter is devoted entirely to commercial equipment, hardly any mention being made of military types.

The fourth edition shows considerable change over the previous edition. Whereas formerly the only airplane described was the Curtiss JN-4, there are no less than twenty representative types briefly described and illustrated in the new edition. The section on engines has been altered to include the more important commercial types which have appeared on the market within the last year or so, and now omits many military and obsolete models which appeared in the third edition. New chapters include the one on airplane construction, a valuable addition though somewhat incomplete, and also those on materials, airships, and S.A.E. standards. The inclusion of the latter is questionable in my opinion, since these are available in convenient form and readily obtainable.

In general, the book is a convenient compilation of material published elsewhere. It accomplishes its purpose very well, although one might wish for a more complete treatment of the elementary theory of the airplane and engine, even for mechanics.

C. F. TAYLOR.

Introduction to Physical Optics. *By* JOHN K. ROBERTSON. *T. Van Nostrand Company, New York. 422 pages. Illustrated. Price $4.00.*

WHILE written primarily for two classes of students: First, those who, at the outset of an intensive study of physics, are laying a thorough foundation for subsequent work in the theory of optics, and second, those specializing in other branches of science for whom a general knowledge of the modernized view of light is indispensable, Professor Robertson's book still has an appeal to the general reader desiring some acquaintance with the problems of modern physics. The author, though keeping in mind the rapidity with which views have changed regarding the details of the newer physics, has devoted much space to quantum mechanics, which is not true of many of the present books on physical optics.

A few chapters at the beginning of the book are given to the study of geometrical optics, but the greater part of the first seventeen chapters considers optics from the physical side. This forms an excellent basis for the introduction of the quantum theory, which is considered from the viewpoint of its historical development. In connection with the subject of wave motion, dispersion of light involving the use of the prism, spectrometer and spectroscope is discussed. Polarized light and the phenomenon of rotary polarization are treated quite completely. The remainder of the book deals with the quantum theory, considered as a result of Planck's radiation formula, and the subsequent work of Bohr, Einstein, Millikan, Sommerfeld, de Broglie and Schrödinger.

Mention should certainly be made of the excellent photographs and line diagrams which help to express the ideas from a physical standpoint. The index is quite complete and should make the book useful as a reference work. At the end of each chapter the author has introduced a set of problems *with answers* which make his text quite adaptable for classroom use.

C. W. R.

Technique of Executive Control. *By* ERWIN H. SCHELL, *Professor of Business Management, Harvard Graduate School of Business Administration and the Massachusetts Institute of Technology. McGraw-Hill Book Co., Inc., New York. 143 pages. Price $1.75.*

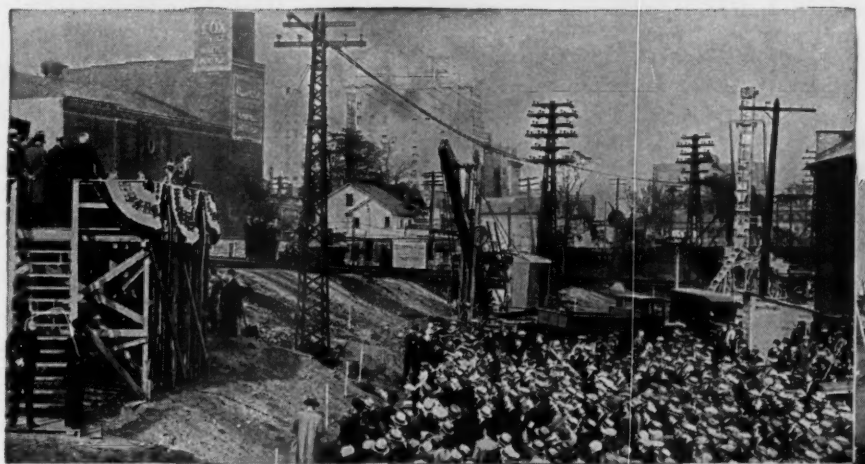
EXECUTIVE skill is usually taken for granted and you either have it or you haven't it. Professor Schell takes issue with this idea and claims that it can be developed in the same way as mechanical, literary, or other forms of skill. Undoubtedly, a great leader, as a great artist, is born rather than made, but nevertheless, it is possible to develop merely ordinary talents to a high degree by the proper study and thought.

In developing a guide for executives, it is clearly impossible to lay down definite rules of conduct to be followed in every case. Human relationships are far too complex for such treatment. However, there are certain tendencies and modes of behavior which are common to all of us, and a thoughtful study of these is of great aid in formulating executive action. Again, it is possible to know one's self. With a knowledge of his own personality and the fundamental tendencies of behavior, the executive can work out his own rules of self-conduct.

The book is in the nature of a discussion, and its purpose seems to be not to provide information but to offer food for thought. It takes up all the various relationships of a foreman to his men and the tools at the executive's command for building coöperation, eliminating discontent, and stimulating loyalty and respect. It discusses the problems and difficulties frequently arising in an executive's position. Modes of conduct and approach are suggested, but throughout, the need for relating these with the reader's own personality is stressed. This is done by questions and cases inserted after the development of each idea to force the

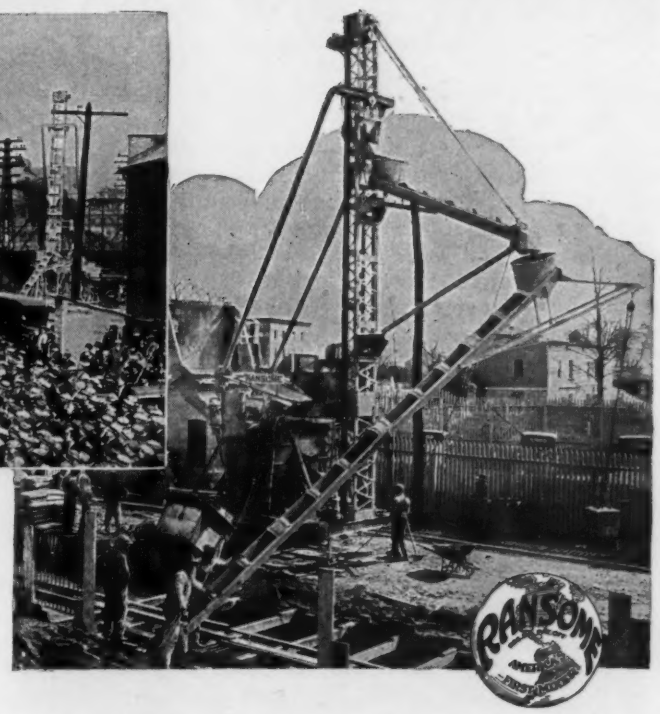
(*Continued on page 426*)

Ransome 27-E PAVERS with FOLDING MAST PLANT help elevate L.I.R.R. TRACKS



International News Photos, Inc.

Mayor James J. Walker addressing the crowd at Jamaica, L. I. at the ceremonies starting the elimination of six L. I. R. R. grade crossings.



More and more, the big contractors who construct long, high retaining walls, foundations, and do grade elimination work are using the Ransome 27-E Paver with a Folding Mast Plant. This unit has a large capacity for output and its portability makes it most popular.

The complete unit is a Ransome 27-E Paver with a hinged steel mast, a bucket and hoist. The bucket holds a cubic yard. The hoist is attached to the paver and is driven from the paver power plant. The control levers for the hoist and brake are so located that one man standing on the operator's platform can operate the mixer and mast bucket.

A boom chute plant equipped with a counterweight chute is the most satisfactory way of distributing concrete. The lower end of the counterweight chute can be easily and quickly shifted along the forms. If chuting is not desired, the concrete can be discharged into a floor hopper and carted.

The complete mast attachment can be taken off and a standard boom and bucket be installed for regular road work.

Compact—well balanced—easy to maneuver!

1930 CONVENTION & ROAD SHOW A.R.B.A. ATLANTIC CITY N.J. JAN. 13-18

Send for the circular which gives complete details and specifications.

Ransome Concrete Machinery Company

1850—Service for 80 Years—1930

Dunellen New Jersey

Design Problems of a New Car

(*Continued from page 403*)

The valves are operated by a single camshaft equipped with 32 integral cams located at the base of the Vee. This shaft is a hollow steel forging and is supported by five bearings. It is driven by a Morse silent chain from the crankshaft, this same chain also driving the generator and the water pump. Chain wear is automatically absorbed by a spring actuated idler sprocket.

The cams operate the valves through roller cam followers, duraluminum push rods, and rocker arms. This mechanism, incorporating the automatic valve silencer already mentioned, differs from the conventional overhead valve engine in that each of the rocker arms oscillates on a bushing eccentric with respect to the rocker arm shaft. Rotating this bushing about its shaft draws the rocker arm down tight against the valve stem and the push rod, eliminating all clearance. This eccentric bushing carries an arm, as may be seen in the accompanying illustration, which bears against a small piston. This piston operates in a cylinder filled with oil and is constantly tending to rotate the eccentric under the influence of a small spring between the piston and cylinder head of the silencer. This action tends to eliminate all clearance, giving quiet valve action without the necessity of adjustment. When expansion of the valve stem takes place the eccentric bushing tends to rotate, forcing the piston into the cylinder. The oil in the cylinder escapes between the piston and cylinder wall and the small spring is compressed slightly, permitting expansion to relieve itself. Oil returns to the cylinder through a spring seated valve within the piston as soon as the conditions permit the piston to raise again.

The oil is used to prevent action of the piston with each movement of the valve, as it cannot escape past the piston rapidly enough to permit response to anything but continued pressure. In actual operation these parts move through only a few thousandths of an inch. Both intake and exhaust valves are of silichrome steel with a clear diameter of $1\frac{5}{16}$ inches. Double valve springs are used to eliminate valve spring surging and clatter at high speeds.

Oil for the engine is supplied under pressure to all bearing surfaces from a reservoir already described which is completely covered by a fine mesh copper screen.

The oil pump is mounted on the rear main bearing cap and driven by spiral gearing from the rear of the camshaft. It delivers the oil under pressure to each of the five main bearings through a copper header from which it flows through drilled passages in the crankshaft registering with the main bearings, to the connecting rod bearings and through the rifle drilled rods to the wrist pin bushings. Oil is delivered to the rear camshaft bearing from which it enters the hollow shaft and lubricates the four remaining camshaft bearings through holes drilled in the shaft. Overflow from the front of the shaft is supplied to the timing chains. An external A. C. oil filter mounted on the dash is supplied with oil under pressure and delivers clean filtered oil to the rocker arm shafts, from which it flows through the bushings lubricating them and then through passages in the rocker arm dripping on the automatic valve silencers insuring a supply of clean filtered oil to these important units. Oil drains back from the cylinder heads

(*Continued on page 418*)

1855 • SEVENTY-FIFTH ANNIVERSARY • 1930

Measuring the progress of 75 years

From small shops to vast factories . . . from blacksmith's forge to six-ton electric furnaces . . . from Joule's theory of heat to superheat . . . from guesswork to science . . . from waste to economy—these hint the revolution in industry since 1855.

The growth of Crane Co. through these years is a significant reflection of the growth of all industry. From a one-man shop founded three-quarters of a century ago, it has grown to a world organization, meeting in its own factories the power and production problems that have faced other manufacturers. Supplying the piping materials that have released power, effected economies, and increased production everywhere, it has of necessity met and solved piping problems as they have arisen in all industries.

Now in its 75th anniversary year, it serves all industries with the materials developed, the knowledge and experience gained. To engineering students, its customers of the future, it offers a valuable reference book and research manual on metal reactions under high pressure and superheat: "Pioneering in Science." Write for it.

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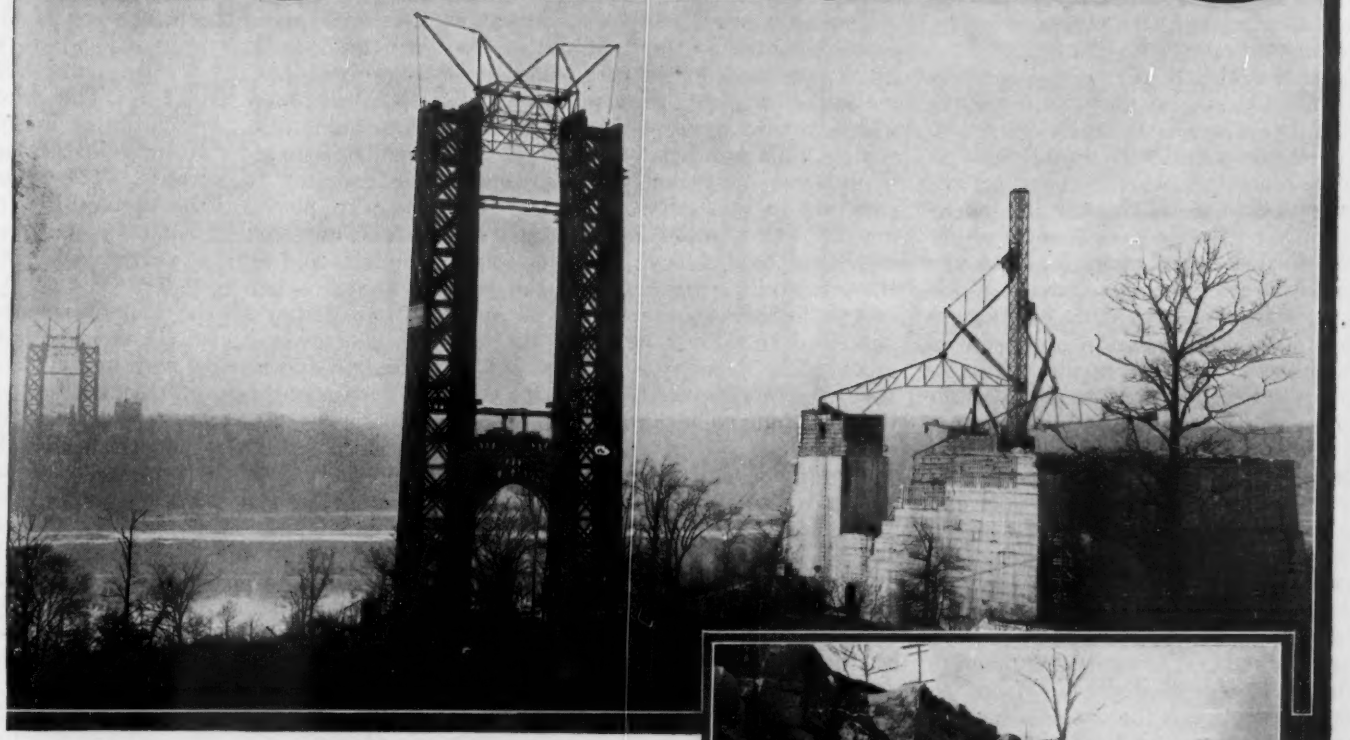
KOEHRING



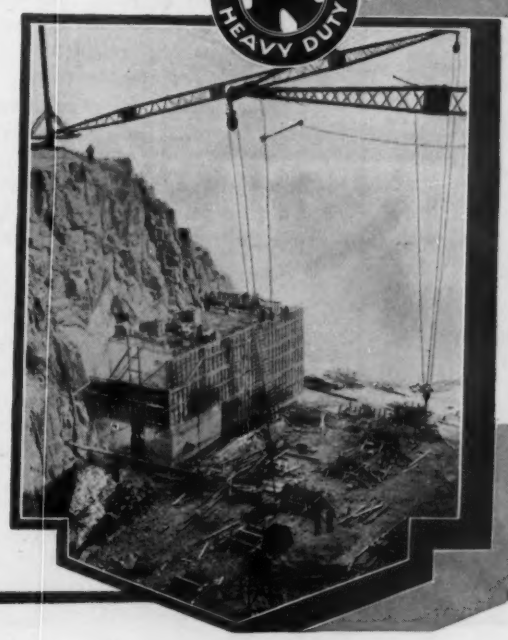
Anchorage for the Longest Suspension Span

A bridge with a main suspension span of 3500 feet, the longest in the world, will soon cross the Hudson river at New York. Suspension will be maintained by four 36 inch cables supported on steel towers 635 feet above the water level.

Abutments on the Fort Lee approach are shown in preparation in the views at the right. Two Koehring Heavy Duty products, a power shovel for the rock excavation and a paving mixer for turning out the Dominant Strength Concrete, were used in this work.

The massive New York anchorage above, 200 feet by 300 feet ground dimension and 125 feet in height, contains 110,000 cubic yards of quality controlled concrete mixed by two Koehring Heavy Duty Mixers.

Another identification of the Koehring re-mixing action with a structure built to endure!



The revised edition of "Concrete — Its Manufacture and Use," a complete treatise and handbook on present methods of preparing and handling portland cement concrete, is now ready for distribution. To engineering students, faculty members and others interested we shall gladly send a copy on request.

KOEHRING COMPANY

MILWAUKEE, WISCONSIN

Manufacturers of

Pavers, Mixers—Gasoline Shovels, Cranes and Draglines

Division of National Equipment Corporation

Design Problems of a New Car

(*Continued from page 416*)

around the valve push rods into the reservoir at the base of the engine to be recirculated. Special packing is used to seal the valve stems, preventing oil from flowing down the stem into the combustion chamber.

All oil draining back into the reservoir must pass through the screen covering its entire area, already described. The oil pump draws its supply through a pipe extending below this screen. Oil is supplied to the engine through openings in the valve rocker covers of either side of the engine, draining into the crankcase around the push rods. Cooling of the oil is secured by cast aluminum cooling ribs on the underside of the reservoir. An oil pressure regulator for the entire system is provided on the timing chain cover plate.

Crank case ventilation to minimize the difficulties of oil dilution is secured by drawing air into the crank case from an opening on the left side of the engine which is fitted with an air cleaner. The crank shaft with its compensators acts as air pump drawing air into the case. Circulation is further assisted by directing the fan blast towards this opening. The only radical departure from accepted practice is the use of a thermostat to close the air inlet after normal operating temperatures are reached. This has been done so as to prevent oil vapors from being expelled from the case and has proved satisfactory since excessive dilution only occurs at low temperatures and under starting conditions.

Cooling is provided by a single water pump mounted on the right side of the crank case and driven through an extension of the generator armature shaft which in turn is driven by the timing chain. This pump is of the dual delivery type delivering water in equal amounts to two outlets in the pump housing. One outlet is connected directly to the right cylinder block and the other outlet connects with the passage in the rear of the crank case already described to deliver water to the left block. The capacity of the system is seven gallons and with a radiator core depth of four inches provides adequate cooling. A belt-driven six-blade fan mounted on ball bearings and thermostatically controlled radiator shutters complete the cooling system.

Fuel is carried in a 25-gallon tank at the rear of the car and is delivered to each of the two carburetors through a separate fuel line vacuum tank and strainer. This provides two completely independent fuel systems, one for each bank of eight cylinders. Carburetors are 1½ inches single jet air valve units incorporating a throttle pump and thermostatic control as used on popular eight-cylinder cars.

The intake manifold is provided with a hot spot giving uniform heat under all operating conditions. Two carburetors were adopted and have provided better distribution than could be obtained with a 45 degree Vee in any other way. The difficulties inherent to distribution of gas to eight blocks have not affected the distribution in this system because of the unusually small displacement of each individual cylinder and the consequently smaller disturbance in the manifold during the inlet stroke of each cylinder. Vacuum for the vacuum tanks is obtained by a small vacuum pump driven from the rear of the camshaft. This insures adequate vacuum at high speeds when the intake manifold depression is not very great and gas consumption is at a maximum.

Two separate exhaust systems have been provided with manifolds, mufflers and tail pipes for each block of eight cylinders. The exhaust manifold has been cast in three sections with expansion joints so as to prevent distortion of the cylinder blocks, and the cracking of manifolds from expansion. We have found this construction essential in blocks of this length.

The electrical system is of conventional design and Delco-Remy manufacture. The distributor is provided with a breaker mechanism containing an eight-lobed cam and two sets of contact points. Two condensers and two coils are also provided. The coils have been mounted in the top of the radiator, a rather unusual location, so as to obtain low temperatures and short leads to the distributor. The wires from the ignition switch on the instrument board are led to the coils through the radiator brace rods. The spark plugs are placed in the Vee and located in the combustion chambers between the inlet and exhaust valves. One plug is used for each cylinder.

The design of the chassis requires great consideration to insure adequate strength and rigidity with an engine of this size and power. A wheelbase of 148 inches was adopted with a total spring base of 102 inches on each side, representing 64 per cent of the entire wheelbase. The frame channel section is nine inches in depth and of 5–32 stock giving unusual strength. The suspension of the engine in the frame is unusual in that a five-point suspension is adopted to effectively absorb the torque reaction and prevent undue stress in the power plant.

Two mountings are placed on the front end cover, two on the flywheel bell housing and the fifth at the rear of the transmission. All mountings are made with rubber connections absorbing shock and vibration. The axles, clutch, transmission, spring and other units follow conventional design, being necessarily heavier and stronger to effectively handle the power of this engine.

To provide speed such as is found in the V-16, adequate brakes were a necessity. Our experience indicated the type of brake employing an articulated shoe and floating cam would be entirely satisfactory if excessive pedal travel caused by expansion could be minimized. This has been accomplished by changing the mechanical advantage of the pedal employing a vacuum assister to assist the operator in applying the brakes. This assister is simply a diaphragm which is connected to the vacuum in the intake manifolds through the brake pedal to give additional force. The force of the assister is at all times directly proportional to the effort of the driver upon the pedal preventing severe brakes and unpleasant braking action.

In conclusion, this article is only a brief resume of the salient points of the new V-16. The writer has attempted as far as possible to show some of the problems which have to be met in designing a new automobile of certain prerequisite capabilities and how some of these problems have been overcome.

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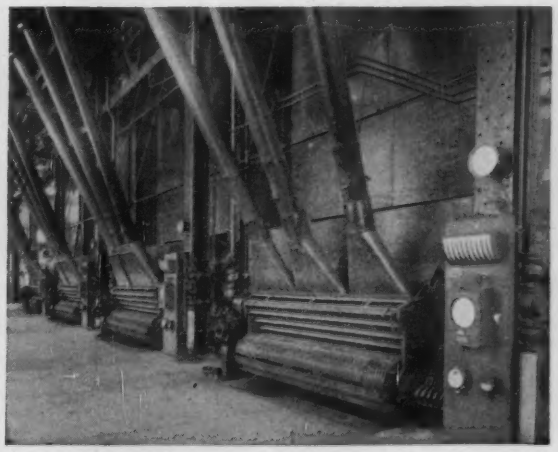
Write for Bulletin No. 81B

Bailey Meter Co.
Cleveland, Ohio



Bailey Meters in a Large Oil Refinery

The Akron Zeppelin Hangar

(*Continued from page 401*)

wires can be tolerated above the ground surface. At the transformers the current is converted into 460-volt, 60-cycle, three-phase for power which is delivered to the main switchboard, housed in the same building with the transformers. Six secondary transformers are located at convenient distributing points just outside the building walls, designed to receive primary current at 460 volts and distribute at 115–230 volts for lighting purposes.

The general lighting consists of adjustable projectors of 1000-watt capacity each, located along the catwalks and upper platform. Additional lighting is provided at all stair and hoist landings. Outlets for extension cables are provided at all trusses, 80-foot centers, at both sides of the building and in the tunnel at the center. Most of the manufacturing operations will be carried on by lights taken from these outlets. Power at 460 volts is carried to a point near the center of the building, on the top platform, where it is distributed to the crane and hoist motors. Separate power feeders are carried to each of the door motors direct from the main switchboard. Each main feeder is protected by an automatic circuit breaker, as no fuses of any description are used on the main switchboard. This is a precaution adopted to prevent an extended shutdown, due to unreliability of fuses.

The roofing on the dock is incombustible and water-tight, furnishing the maximum practicable amount of insulation, as well as meeting certain strength requirements. For the upper half of the structure, a test load of 200 pounds per square foot must be applied downwards or upwards, with a deflection of not to exceed two per cent of the span. For the lower half, a test load of 100 pounds per square foot is required, applied in a manner similar to that for the upper half, with the same unit of deflection.

Insulation was an important factor in the roofing requirements. It is desirable that condensation of moisture on the under surface of the roof should be reduced to a minimum, and to accomplish this it was originally intended that all of the covering, except the vertical sides, should be insulated. However, on account of the great cost of installing this area of insulated roof, it was decided to insulate only a strip across the top, about 100 feet in width, at present, and provide for extending this insulation farther down the sides if experiments, to be carried on during the first year of plant operation, should determine this to be necessary.

Due to the fact that no precedent had ever before been presented to the fire underwriters, new rulings were required for the building, the insurance interests requesting that only incombustible materials be used in the construction of the dock, which eliminated wood roofing. It was also requested that outside and inside fire hydrants be installed and connected to an automatic fire pump just outside the building and capable of increasing the normal pressure of 50 to 60 pounds per square inch to 125 pounds per square inch.

The taking in and out of a dock a large airship is no easy task. Great care must be exercised, as injury to the ship is practically certain should it strike any part of the building. Cables must be attached to the ship's hull at certain fixed points and to trolleys which run on fixed tracks, one on each side of the ship. These trolleys are operated by hand, and the ropes are held by quick-release levers, so that any undue strain can be quickly relieved by releasing that cable.

(*Continued on page 422*)

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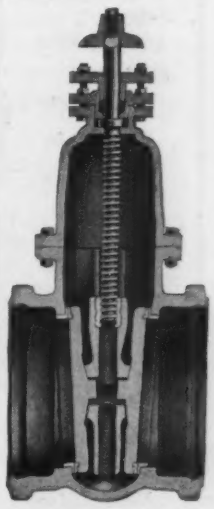
We extend an invitation to all interested students to visit our extensive plant to observe the manufacture of "MATHEWS" Hydrants, and our other products.



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The Akron Zeppelin Hangar

(*Continued from page 420*)

As the tension on these cables may mean over five tons pull on a single rope, applied at an angle of as much as 45 degrees to the vertical, it is obvious that the problem of designing a trolley and track to meet the conditions mentioned is not simple. The docking rails or tracks of the Zeppelin dock consist of two parallel grooves, similar in construction to the trolley grooves used for electric railways in some cities. These tracks are spaced 200 feet apart and extend about 1600 feet beyond each end of the building. The trolleys are of an improved design, made especially for this development.

Along the center line of the building is a standard gauge railroad track, just on top of the tunnel inside of the building, and this is to carry a guide trolley to keep the ship's hull centered to the building while taking it in or out.

Only helium gas is to be used for inflating ships; provision for handling this gas only has been made. The gas is shipped from the fields in small steel containers, about four feet long and nine inches in diameter. Each of these containers — sometimes called bottles — contains about 170 cubic feet of free gas, under a pressure of about 2,000 pounds.

According to Boyle's law of gases, which says the volume is inversely proportioned to the pressure, if the temperature is maintained constant each cubic foot of gas under 2,000 pounds pressure is equivalent to approximately 133 feet of free gas at atmospheric pressure. The ZRS4 and ZRS5 each will require about 6,500,000 cubic feet, therefore it will be seen that 38,000 bottles would be required. The United States Navy is building special tank cars for transporting helium. Each car will carry about 600,000 cubic feet of gas, and it is more than likely that the gas for the Akron ships will be delivered in this manner.

Work on the first of the two great ships for the Navy was formally begun on November 7, when approximately 50,000 people attended the ring-laying ceremony, a service comparable to the keel-laying of an ocean liner or battleship. A golden rivet was driven into the master ring by Rear Admiral William A. Moffett, chief of the Bureau of Aeronautics, United States Navy. Although only about one-half the building was under roof, the sheltered section conveniently accommodated the vast throng attending the celebration.

The master ring was completed December 15 and now is undergoing certain tests, while work has been started on the second ring of the series. Thus, with the completion of the giant dock and operations under way in construction of the largest airships in the world, another great stride is made in placing the United States far in the forefront in the realm of aviation.

A Deluge System of sprinkler protection has recently been devised and used for the protection of airplane hangars. The system is actuated by the expansion of heated air from hollow metal balls through capillary tubes and is thus affected only by the rate of rise of temperature rather than by the specific temperature of fusion as is the case in the fusible plug system.

Although the pipes of the deluge system are dry when not in operation, in tests water was delivered to a small blaze over one minute in advance of the fusible plug system, and in larger fires, the time difference was much greater. Due to the fact that the entire system is put into operation by one control, this new sprinkler finds a more suitable field in large hangars than in the average building.

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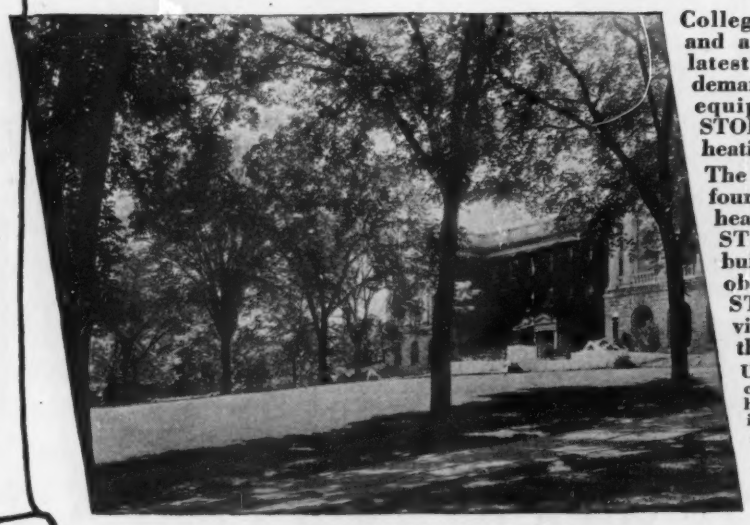

In a setting like this the power plant should be smokeless.

College engineers, with a wide and accurate knowledge of the latest scientific advances and demanding the best in modern equipment, specify TAYLOR STOKERS for college power and heating plants.

The University of Wisconsin found that by remodelling its heating plant with TAYLOR STOKERS the necessity of building a new plant could be obviated. The new TAYLOR STOKER installation provided *twice* the capacity of the former heating units.

University of Wisconsin engineers credit TAYLOR STOKERS with helping to reduce the cost of heating from $43.90 per semester per student in 1918 to $18.53 in 1927.

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Remote Control of a Distributing Station

(*Continued from page 405*)

passed, the relay called "group-step-over" will cause the first "group" relay to drop out and will pick up the second "group" relay to replace it so that the "register" in running through its sequence for the second time now applies the impulses to the second group of ten instead of the first. This brings the relay chain to point number twenty in the sequence. In like manner the functioning of the "register" is now "stepped-over" to the third group, then to the fourth group and so on until the "register" has reached every point in the "relay chain."

Meter readings are selected one at a time over the relay chain, carried over the telephone connecting lines, and are recorded directly on standard meters at the control station. This system is known as rheostatic or current balance telemetering, and is accomplished by the use of a rotating drum upon which is wound a resistance wire in the form of a helix. As the drum rotates in response to a change in condition of the units measured, the amount of resistance between a fixed terminal and the moving terminal is changed. This in turn influences the amount of current which is sent from the transmitter over the connecting telephone lines to the receiver at the control station. The receiver consists essentially of a standard meter with a D'Arsonval movement calibrated in the unit to be measured. The drum rheostat of the transmitter is operated by a Kelvin balance or dynamometer. As long as the balance is in the neutral position the drum is stationary. When the balance is moved from the neutral position by a change in the quantity of electrical energy being measured, the drum rotates until the circuit is again balanced.

The supervisory system is capable of performing the following control and metering functions:

Operation of all oil circuit breakers.

Indication of energized or de-energized feeders.

Control of induction regulators.

Indication of bus ground detectors.

Indication of overheating of transformers.

Control and indication of station battery motor generator sets.

Control and indication of station and street lighting equipment.

Indication of low voltage on station battery.

Indication of opening and closing of station entrance doors.

Meter readings of transformer current, feeder current and regulator and bus voltage.

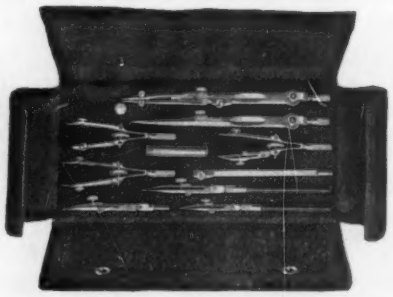
Wattmeter readings of incoming high tension feeders and transformer banks.

The supervisory equipment is made up largely of standard telephone relays and equipment and is operated by 48 volts direct current supplied at each station. The operation is unusually fast and individual controls and indications can be accomplished in the order of five per second. It is interesting to note that an entire distributing station can be operated and metered by a single individual from a control board about 12 feet long.

Artificial Marble is now being manufactured by a western corporation. The material in a semi-liquid consistency is poured into moulds where it hardens to form a solid resembling marble in color and markings, but weighing somewhat less. By the addition of color in the plastic state, the product may be tinted to any desirable shade. As it comes from the moulds, the material has a smooth, lustrous finish and, unlike marble itself, requires no polishing or buffing.

Dependable Drawing Instruments

FOR THE UNDERGRADUATE AND PROFESSIONAL



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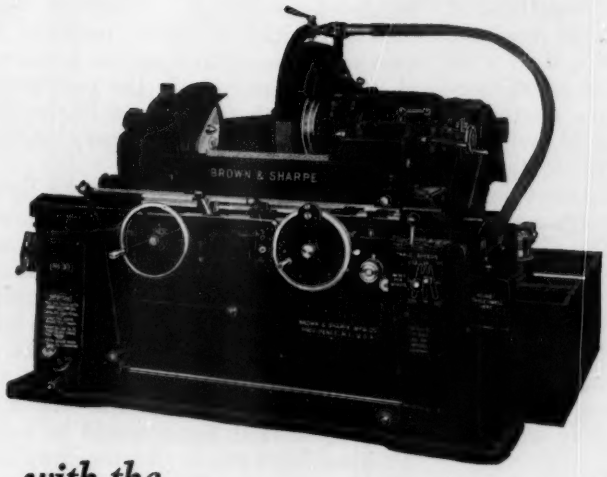

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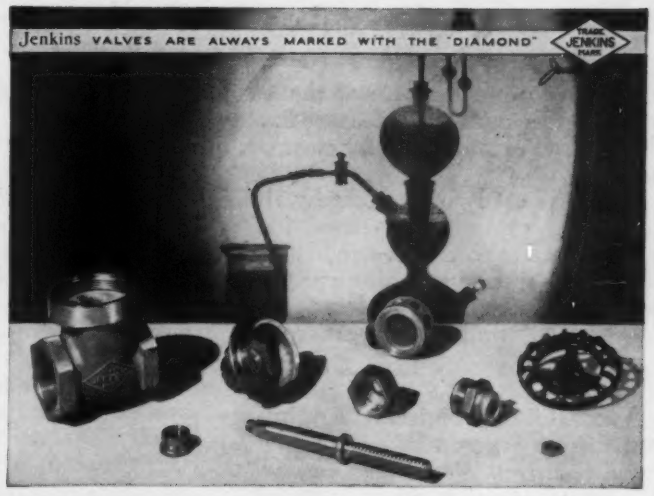

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Jenkins
VALVES
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Recent Books

(*Continued from page 414*)

reader to formulate his own thoughts on the subject. This last feature makes the book an excellent one for classroom use.

A careful study of the text by those occupying, or those who hope to occupy executive positions, should greatly clarify one's mind and also equip it to better attack the problems which sooner or later all executives face.

C. F. E.

Vibration Problems in Engineering. *By* S. TIMOSHENKO. *D. Van Nostrand Company, New York City. 1928. Illustrated. Price $4.50.*

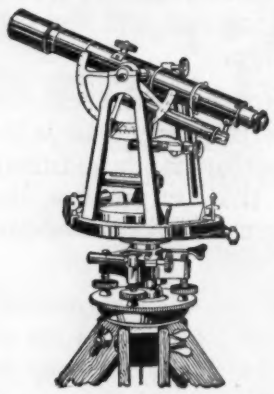
MODERN methods have produced larger machines operating at higher speeds. This development has brought vibration problems of great practical importance and the engineer has found that he has had the greatest difficulty in solving them.

The author presents a logically developed theory of vibration and points out that by the use of the theory the most desirable design proportions may be found so that working conditions will not be in the critical range where heavy vibrations may occur. Technical applications are illustrated by examples from the author's experience with the vibration of machines and structures.

The volume is divided into five main chapters. Under Chapter I "Harmonic Vibrations Having One Degree of Freedom," the general problem of free and forced vibrations is discussed and the operation of balancing machines described. Chapter II includes the discussion of non-harmonic vibrations of systems having one degree of freedom. Chapters III and IV which deal with systems having several degrees of freedom and elastic vibrations contain a large number of examples of technical applications. An appendix contains a description of the more common forms of vibration-measuring instruments.

In this volume the author has presented the vibration problem to the engineer in a scientific manner. His masterful knowledge of the subject is placed before the reader in a clear and concise fashion. Here is a text that will be the standard treatise on the subject. The volume merits a place in every engineer's library.

L. H. YOUNG '15.



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Departmental Notes

(*Continued from page 412*)

with the Department of Physics, attention being at present focussed on quantum mechanics.

The graduate students are very active and are devoting much of their time to original research, much of which would be unintelligible to the average undergraduate. The following are three of the more understandable and recent of their problems: the determination of new methods of attack and certain special cases of the problem of a loaded vibrating string of varying density, the application of certain theorems allied with the Tauberian theorem, and the derivation of interpolation and integration formulae.

Last term Professor Tyler was in Washington on leave of absence from the Institute, establishing the Central office of the American Association of University Professors, of which organization he is the secretary.

H. W. TYLER '84.

Shadowless Illumination has been secured by a New York dental surgeon who uses three independent sources of direct light, each projecting an intense beam. By means of a single control, these beams may be converged simultaneously to any focal point. The entire mouth is illuminated without shadows by the three circles of light thus superimposed upon each other, while their angle of direction protects the patient's eyes from glare.

Chemistry in Agriculture

(*Continued from page 407*)

of strong mineral acids, and the cellulose can therefore be removed from ligno-cellulose materials by hydrolyzing with acids, leaving a residue of lignin substances. Since, however, cellulose has industrial value, it will probably never be practicable to destroy the cellulose for the purpose of obtaining lignin for any uses that may be developed for it. Moreover, such vast quantities of lignin, modified by various chemical treatments, are available as by-products in the production of cellulose that it is not likely that lignin will ever be the primary product of any industrial process.

The problem is to utilize the lignin in the spent liquors from pulp plants. Various methods for using such liquors have already been discussed under "By-Products of Cellulose Manufacture." A number of investigators have noticed a close relationship between lignin substances and tannins, and P. Klason* states that the similarity is so great that lignin could be called an insoluble tannin. A promising field of investigation into uses for lignin seems, therefore, to be a study of possible methods for converting lignins into soluble tannins, the need for which is becoming more and more acute as chestnut wood, the principal source of tannin in this country, approaches extinction by blight. This will necessitate further study of the constitution of both lignin substances and tannins.

Primary Products Other than Cellulose

Instead of treating ligno-cellulose materials to obtain cellulose as the principal product, with possible recovery of non-cellulose by-products, one may obtain other products by fermentation, dry distillation, or chemical treatment.

There are numerous microörganisms which will thrive on ligno-cellulose materials and bring about chemical changes through enzyme action. Some of these destroy the cellulose, whereas others attack the lignin or non-cellulose constituents. Some thrive in the presence of air; others grow only in the absence of air. By regulating conditions so that they are favorable to the action of particular organisms or groups of organisms, certain main products can be obtained. It has been proposed to ferment waste ligno-cellulose materials mixed with sewage (to supply nitrogen) under anaerobic conditions for the production of fuel gas consisting principally of methane. Carbon

(*Continued on page 428*)

*"The Chemistry of Lignin Bodies." Technical Association Papers (T. A. P. P. I.), 11th series, June, 1928, p. 100.

A. R. NELSON
Testing Engineer
Iowa State College, '25

H. R. MICHEL
Engineer of Purchases
Montana State College, '20

H. B. MAYNARD
Supt. of Production
Cornell, '23

J. A. WILSON
Headquarters Sales
Drexel Institute, '25

I. R. CUMMINGS
Application Engineer
University of Illinois, '21

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The steam locomotive has a new rival

ATTENTION in railway circles focuses this year on a spectacular undertaking by the Canadian National Railways—the electrification of certain trains on non-electrified lines.

One great oil-electric locomotive is already in service. The largest and most powerful of its type in the world, this giant electric locomotive that carries its own generating plant develops 2660 horsepower, uses only .43 lb. of fuel per horsepower-hour developed at full load.

Many interesting features are incorporated in its design. The speed and voltage of the engine-generators are automatically controlled by the power demands. The engine exhaust is directed through automatically regulated economizers that heat the coaches and serve as well as mufflers. Control is placed at both ends, to enable running in either direction. Only in a difference in gearing need the passenger type units differ from those adapted to freight service.

In the development of this locomotive Westinghouse engineers co-operated with the Railway's own engineers and leading locomotive manufacturers and frame builders. Every year hundreds of important jobs in which electricity is involved are delegated to Westinghouse, the clearing house for electrical development.

Westinghouse

Chemistry as an Aid to Agriculture

(*Continued from page 426*)

dioxide, which is also produced, can be removed by absorption with lime or alkalies. After converting the cellulose of ligno-cellulose materials to dextrose by hydrolysis with acid, the neutralized material can be fermented for the production of alcohol. Ligno-cellulose materials like straw can also be used to produce artificial manure high in humus by fermenting with certain micro-organisms and adding water and nitrogenous (and perhaps also mineral) substances to hasten the process. With certain organisms and under suitable conditions, various organic acids can be produced. The production of definite products from ligno-cellulose waste by microbiological processes appears to be a promising field for investigation.

Both the cellulose and non-cellulose constituents of ligno-cellulose materials yield volatile products and residual carbon by dry distillation. The products vary with the character of the raw material and conditions of distillation, and may include acids, alcohols, esters, aldehydes, ketones, organic bases, phenols, hydrocarbons, carbon monoxide, carbon dioxide, and water. The entire distillate is divided physically into non-condensable gases and a liquid mixture consisting of aqueous and non-aqueous layers. The aqueous portion, commonly called pyroligneous acid, contains methanol, acetic acid, acetone and other substances soluble or partly soluble in water. The constituents which are insoluble or practically insoluble in water form an oily or tarry layer. It is very difficult to separate the individual chemicals from those with which they are mixed and the products must therefore be used in more or less crude form. The carbon remaining in the retort may be used as fuel or in some instances, after special treatment, as an absorbent or decolorizer. Recent development of synthetic methods for the commercial production of acetic acid and methanol in pure form will probably limit the production of these chemicals by dry distillation of wood, and makes very doubtful the possibility of producing them profitably from ligno-cellulose crop wastes. Some experimental work has been done on the development of equipment for carbonizing straws and other crop wastes to produce illuminating and fuel gas for rural communities. Such gas, however, has proved so far to be a more costly source of heat than liquid and solid fuels readily available. Attempts to profitably utilize carbon, pitch, tar, oils, and other products from destructive distillation of straw, maintained by combustion of the gaseous products, have not proved to be commercially successful.

It is believed by some chemists that as coal and petroleum have resulted from the decomposition of vegetable material by natural processes, similar materials can be made artificially from ligno-cellulose material by properly controlled carbonizing processes and hydrogenation. F. Bergius* claims to have actually made coal and crude oil artificially from vegetable matter.

It has long been known that cellulose can be hydrolyzed to a soluble carbohydrate, glucose, which has food value, and it has been proposed by F. Bergius† to manufacture cattle food by hydrolyzing ligno-cellulose materials with hydrochloric acid and subsequently removing the reagent without decomposing the carbohydrate formed.

Crop wastes high in pentosans can be and to some extent are used for the production of furfural by cooking them under pressure with dilute acid or with steam alone.

Prospects of Crop-Waste Utilization

Chemical investigations may result in the discovery of new products that can be made profitably from crop wastes, and new and cheaper processes for making known products; better control or improvement of known processes; adaptation of known processes to new materials; and discoveries that will contribute to the extension of present uses, as for example, the development of waterproof and fireproof binders for fiber board. To be of benefit to agriculture in general, products used in large quantities, rather than chemicals having a limited use, must be made from crop wastes.

In conclusion, it may be said that many chemical methods of utilizing ligno-cellulose crop wastes are known and more will undoubtedly be discovered; the engineering problems of applying these methods industrially have been or will be solved; but the application of any method of utilization depends above all upon economic conditions. Possible large-scale products include paper, fiber board, structural material, stock feed, fertilizer, and gaseous, liquid, and solid fuels. But as long as these materials can be obtained at a lower cost from other sources, no material progress will be made in the industrial utilization of ligno-cellulose crop wastes. The ligno-cellulose materials produced annually form a vast source of organic substance that will be utilized when the natural resources of coal, petroleum and timber, the accumulated stores of the past, prove insufficient or approach exhaustion. It is to be expected that the more concentrated materials will be used first.

*Chemical Abstracts, *8*, 1004; *10*, 2398; *11*, 206; *14*, 2414; *16*, 261; *22*, 1027.

†Chemical Abstracts, *19*, 3018; *22*, 4224.

New Containers are being made from old newspapers and periodicals. Paper gathered up is sorted for printed and unprinted material, then placed in large beaters where it is chewed up and soaked with water to form a pulp. Printed matter comes out a pearl gray while unprinted paper comes out a creamy white. Coloring matter is added at this stage to obtain any desired color.

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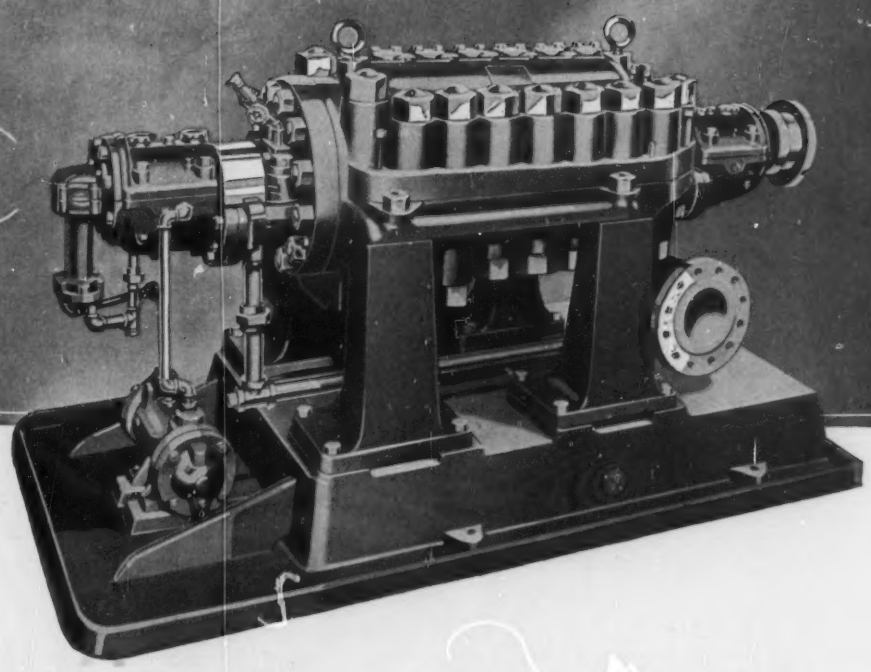

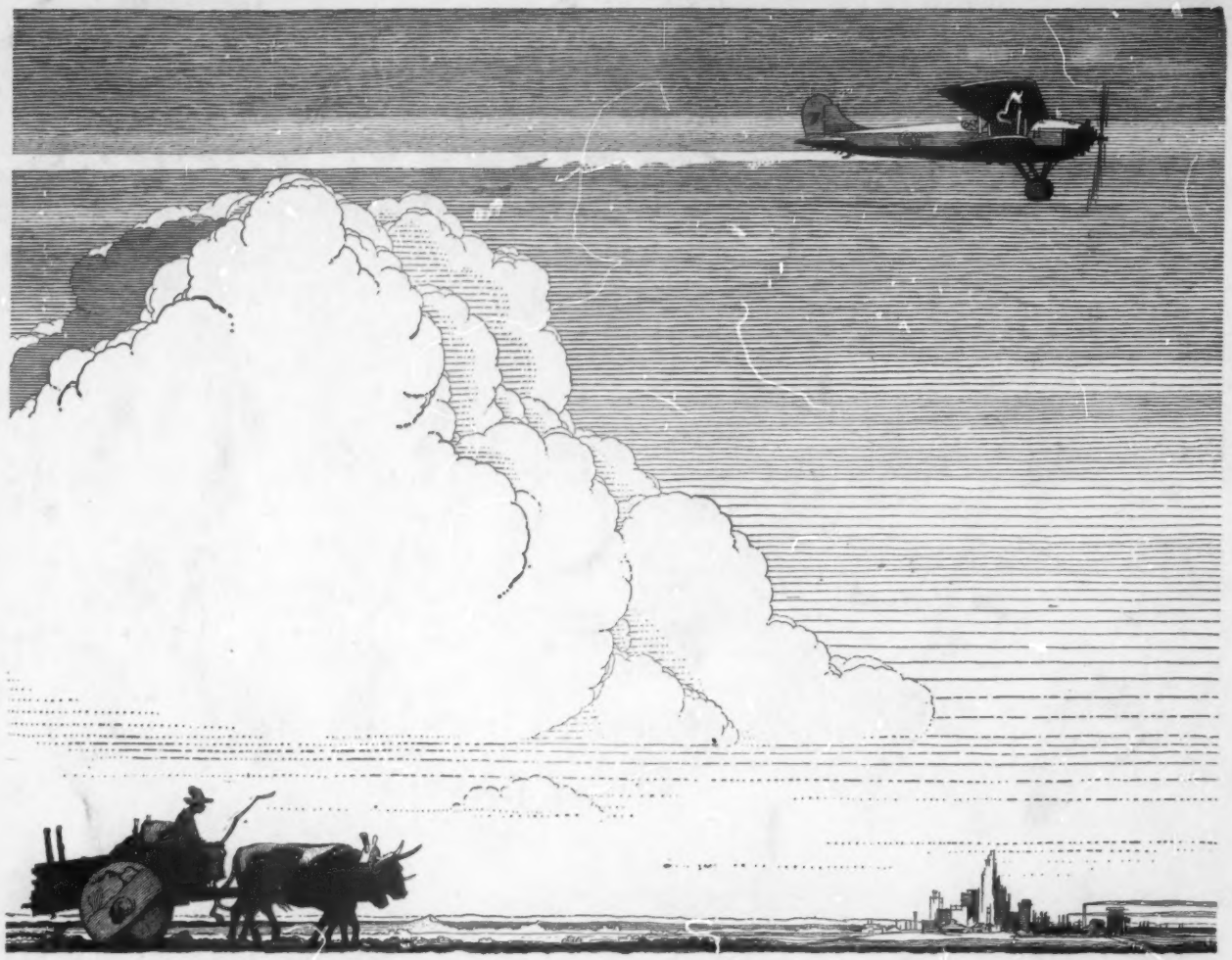

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